ORDNANCE

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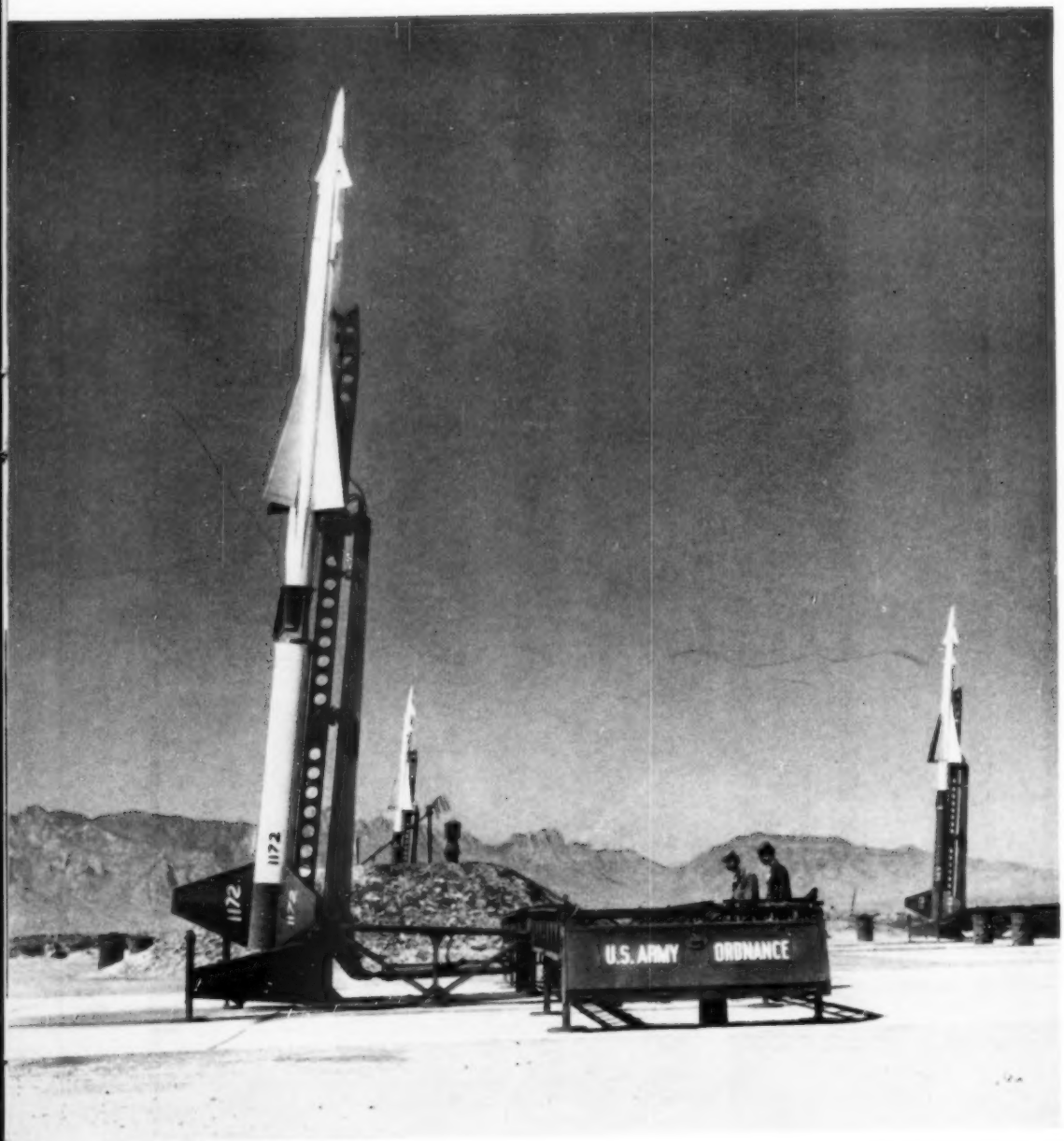
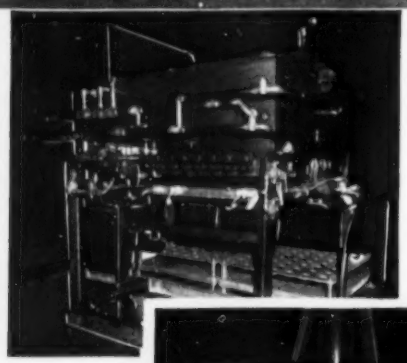


Nike—Symbol of Victory

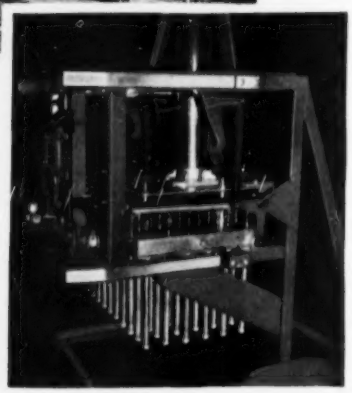
MARCH-APRIL 1954

MEET "MIGHTY MOUSE"

A four-foot "Mouse" complete with fin tail . . . travels 2,000 miles per hour . . . stowaway on all American jets . . . sudden death to aggressor bombers!



Volumetric Pouring Unit



Silvertip Probe

Denser - Safer - Cleaner

POURING—2.75's, 57's, 75's, 90's, 105's, 155's, 8-inch, 60 and 81 mortars, mines, etc., etc., at better than a skid a minute—with NO down time!

MELTING—If it melts at all, TRIPLEX will do it faster!

PROBING — Triplex "Silvertip" Probes Transmit More B.T.U.s Per Second on Less Steam. The Industry's Fastest and Safest—Unconditionally Guaranteed!

ASSEMBLING—Crimpers, Powder Bag Inserters, Jumble Fixtures, Funnels, Concentricity Gauges, Washout Units, Carton Inserting and Taping Machines, Drilling and Facing, Punches and Dies, Angel Buggies, Explosive Handling Trucks, Demil and Rehab, Complete Round Assembly, Etc., Etc.

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Standard of the Industry

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ORDNANCE

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The Magazine of Scientific and Industrial Preparedness

VOL. XXXVIII | MARCH-APRIL 1954 | NO. 203

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70 E. Forty-fifth Street
New York 17, N.Y.

ORDNANCE is published bimonthly by the American Ordnance Association, 705 Mills Building, Washington 6, D.C. Entered as second-class matter, August 14, 1920, at the Post Office at Washington, D.C., under the Act of March 3, 1879. Additional second-class entry at the Post Office at Richmond, Va. Subscription rate: Continental United States and possessions, $4.50 annually in advance; foreign, $6.00. Copyright 1954 by the American Ordnance Association. Title registered United States Patent Office. Six weeks' notice before next publication date required for change of address. FIREPOWER and LOGISTICS, formerly published by the American Ordnance Association, are now combined with ORDNANCE magazine.

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Nike—Symbol of Victory . . . . . **Front cover**
Photograph of the Army's new antiaircraft guided missile

Gen. Nathan F. Twining, U.S.A.F. . . . . . **Frontispiece**
Exclusive photograph for ORDNANCE *by Harris & Ewing*

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Our ability to retaliate swiftly is a deterrent to aggression

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There is a need for better aircraft with more effective weapons

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An editorial about the need for freedom of initiative

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ARMAMENT TECHNOLOGY

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Solving the problem of fitting the vehicle to the terrain

The Helicopter in Combat . . . . . **Joseph Bonanno** 868
The versatile aircraft may bring changes in assault concepts

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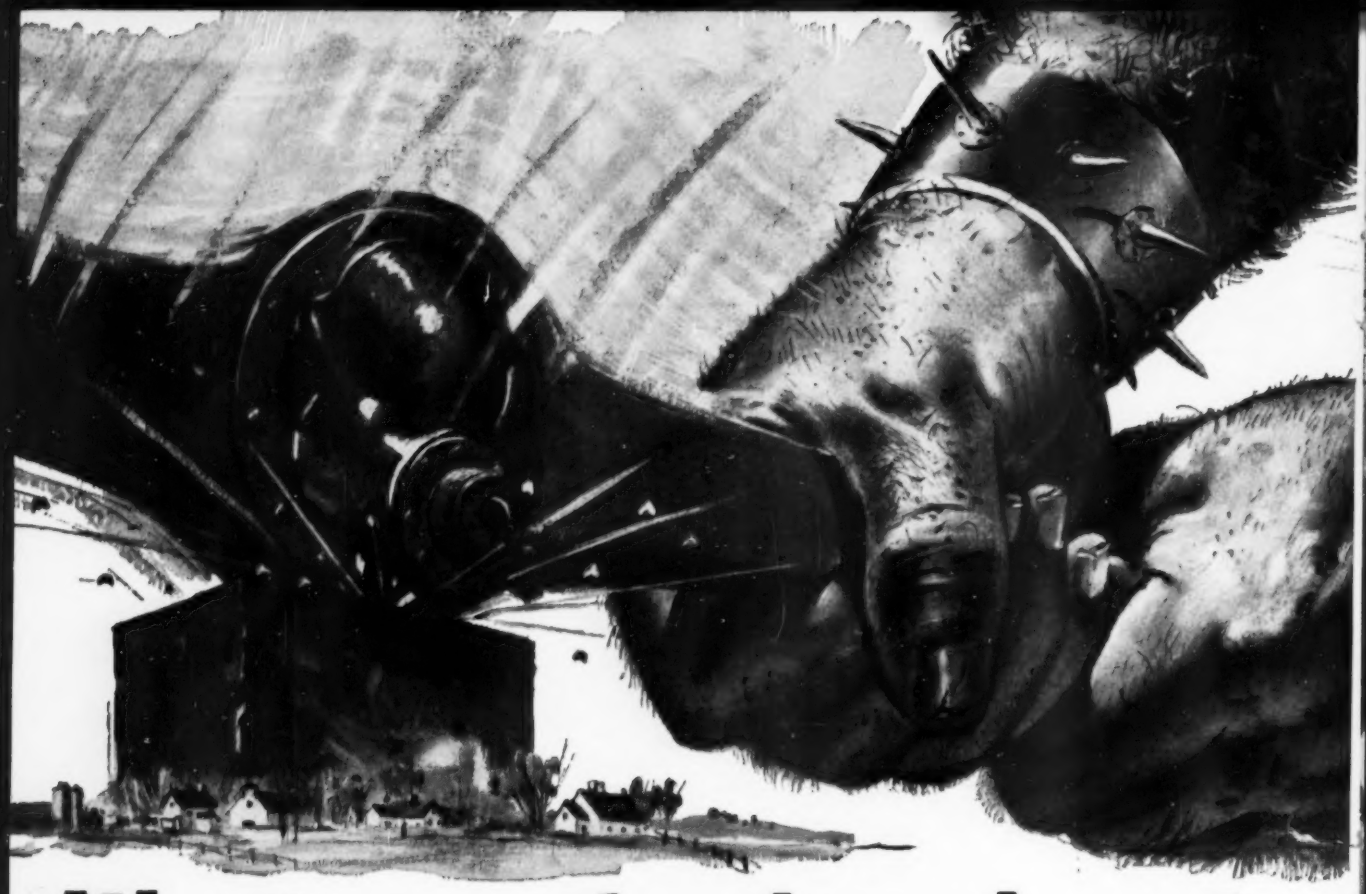
New process gives rise to a growing industry in the U.S.

The Recoilless Gun . . . . . **Roger Marsh** 876
A résumé of the development of this unique weapon



We give truck axles a brutal

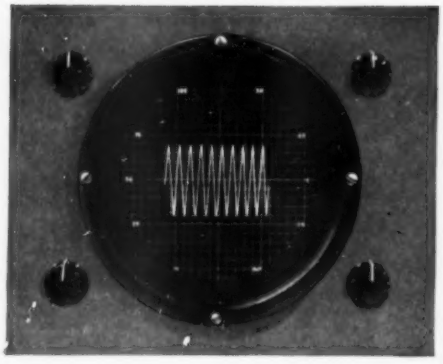
in the new Timken-Detroit indoor proving ground . . . and only

We torture them . . . shock-load, over-speed and jerk them . . . twist, strain and abuse them. We match every on-the-job hauling condition . . . then throw in a few devilish tricks of our own!

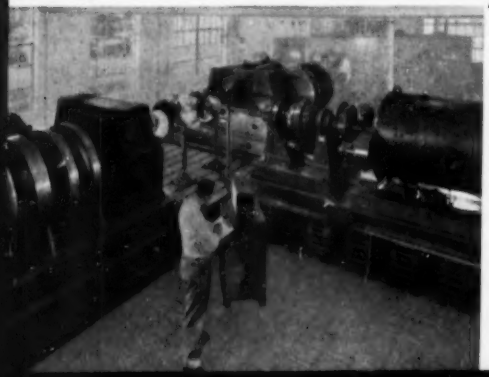
The result? You know for sure that *any* Timken-Detroit axle can take more abuse on the job it was built for than any other axle made!

To prove it, we moved a huge proving ground indoors. In one room we can simulate any hauling situation—our engineers can apply 50 years of experience to perfecting axles for modern trucks, buses and trailers, and measure performance with scientific precision.

This research pays off in longer truck life; less maintenance, repairs and downtime; lower operating costs. No wonder Timken-Detroit axles with Hypoid gearing rate "first" with wise truck owners!



Whatever you haul . . . simulated service conditions show up electronically on a screen like this. For instance—a heavily loaded truck on a bumpy, twisting road—then on a level express highway or long grade. What happens to the axle and gearing is measured, charted with absolute scientific accuracy.



TDA proves axle quality and performance in this "Torture Chamber"

Here we simulate actual highway conditions . . . test quality and performance of axles under any hauling situation, such as duplicating the kinetic energy of 80,000 lbs., G.C.W., at 60 m.p.h. All tests are repeated hour after hour with an automatic cycling control.

No matter the twist, thrust or shock . . . Timken-Detroit axles can take it! Regardless of load, road and speed conditions . . . even the impossible . . . the new Timken-Detroit Straight-Line Drive for the 2½-ton, 6 x 6 military truck is a vastly improved unit.

On Timken-Detroit axles . . . you go anywhere you gotta go . . . and with power and stamina. You can't be choosey in combat . . . and you can't afford breakdowns in schedules *or* the vehicle. And every day, continuous research is adding even greater performance to the 6 x 6.

beating

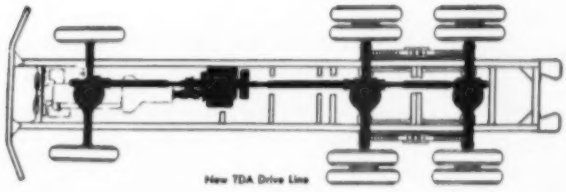
Timken has it!

What's more . . .

INTERCHANGEABILITY . . .

of parts for easier logistics

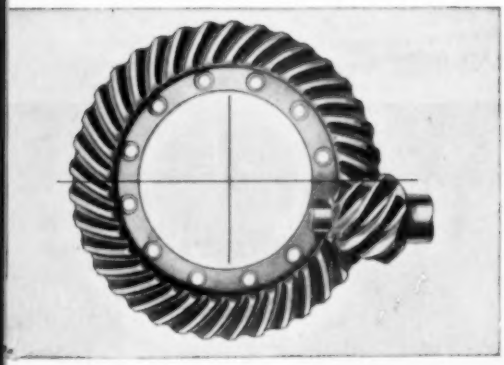
1. **A simpler logistics problem of stowage and palletizing.**
2. **Fewer different parts in stock bins — of vital necessity to military supply officer who must maintain a warehouse on wheels.**
3. **Far greater ease of maintenance.**
4. **Fewer records of parts and service operations to maintain.**
5. **Reduced personnel training time in operation and maintenance.**
6. **More personnel made available for other duty.**
7. **Faster availability between manufacture and use.**



New TDA Drive Line

Here's what makes the Timken-Detroit 6 x 6 assembly "tick"

The new design features a straight-line drive from the front axle through the transfer case to *both* rear axles. This is possible because top-mounted double-reduction final drives are used on all three axles. Ground clearance is increased . . . propeller shaft angles reduced vertically and horizontally.



Hypoid . . . Timken-Detroit's "baby". . . proved in billions of ton-miles of service. Slower gear ratios without loss of strength. Larger bearings . . . bigger, stronger offset pinion . . . more teeth in contact . . . torque transmission increased. Available in world's only complete axle "family"... single-speed; single-speed, double-reduction; 2-speed double-reduction final drive units, in 7 basic capacities covering entire range of medium and heavy-duty requirements.

TIMKEN Detroit AXLES

TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN

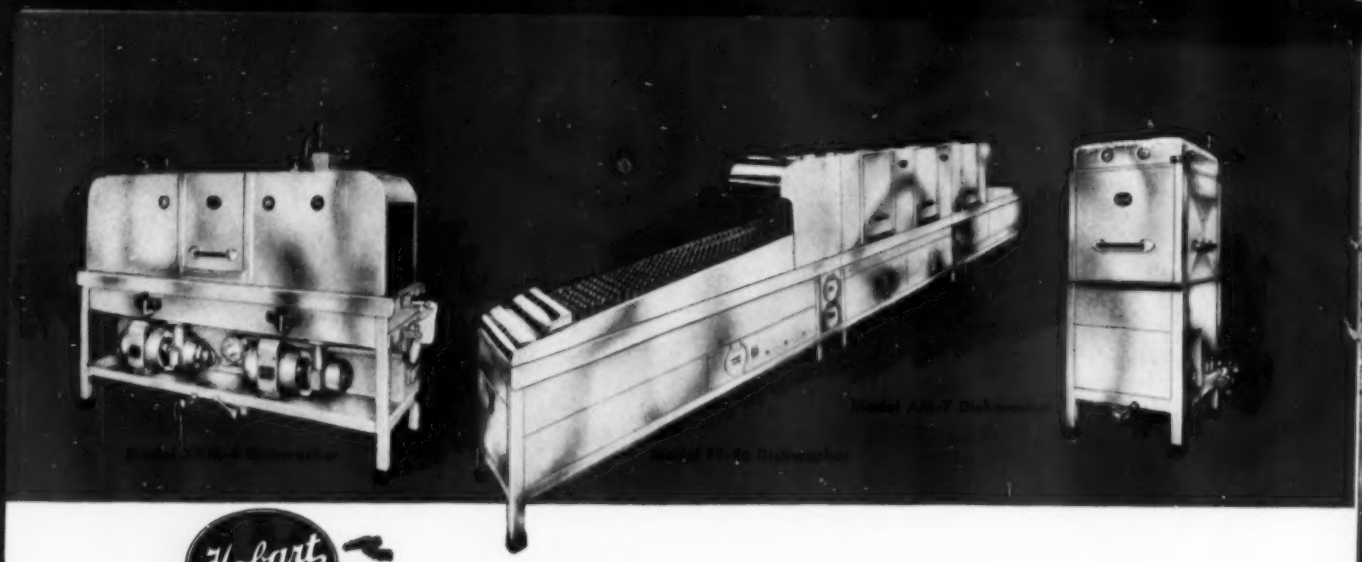
The Accepted D A Standard

TRADE MARK REGISTERED

"TORTURE-TESTED"
to Save Money on the Job

WORLD'S LARGEST MANUFACTURERS OF AXLES FOR TRUCKS, BUSES AND TRAILERS

Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York
Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania



Hobart

Year after year, kitchen operators of all categories buy more Hobart food, kitchen, dishwashing and bakery machines than any other make. Superior design and superior peformance is, of course, one reason. The Hobart guarantee and most convenient service facilities are others. **But isn't the big reason for this overwhelming preference the fact that Hobart machines, year after year, *must have proved* that they return the greatest value for every dollar invested in them?** Our representatives like to be asked to prove this very fact! . . .

The Hobart Manufacturing Company, Troy, Ohio.

Models Representative of the Most Complete Line in the Industry.

Consolidate planning, purchasing and servicing for your entire installation. Hobart does it all! Ask your local Hobart representative—or write for complete information.

WHICH OF YOUR METAL-CLEANING JOBS WOULD YOU LIKE TO IMPROVE?

¶ Are you cleaning metal in the most economical way? *See page 9 of Oakite's* FREE *booklet on Metal Cleaning.*

¶ Are you cleaning metal the fastest way? *See page 11.*

¶ Can you clean brass anodically with no tarnish? *See page 18.*

¶ Can you clean steel and prepare it for painting for less than 20 cents per 1,000 square feet? *See page 24.*

¶ Do you need a cleaner that removes rust and oil at the same time; often eliminating all need for pickling? *See page 28.*

¶ How do you clean parts that are too large to be soaked in tanks or sprayed in machines? *See page 30.*

¶ Does your burnishing barrel produce high luster? *See page 32.*

¶ What do you do when oversprayed paint neither floats nor sinks in your paint spray booth wash water? *See page 35.*

¶ Would you like to eliminate expensive drying from your anti-rust procedure? *See page 37.*

LISTED BELOW are some of the operations discussed in this 44-page illustrated booklet. Please check the jobs in which you are interested. Then let us show you how Oakite methods can give you better production with greater economy.

SPECIALIZED INDUSTRIAL CLEANING

OAKITE

MATERIALS • METHODS • SERVICE

OAKITE PRODUCTS, INC., 14F Rector Street, New York 6, N. Y.

Tell me about Oakite methods and materials for the following jobs:

- ☐ Tank cleaning
- ☐ Machine cleaning
- ☐ Electrocleaning steel
- ☐ Electrocleaning non-ferrous metals
- ☐ Pickling, deoxidizing, bright dipping
- ☐ Pre-paint treatment
- ☐ Zinc phosphate coating
- ☐ Paint stripping
- ☐ Steam-detergent cleaning
- ☐ Barrel cleaning
- ☐ Burnishing
- ☐ Rust prevention
- ☐ Treating water in paint spray booths
- ☐ Machining and grinding

☐ ALSO send me a FREE copy of your booklet "*Some good things to know about Metal Cleaning*"

Name _____

Company _____

Address _____

Technical Service Representatives in Principal Cities of U. S. and Canada

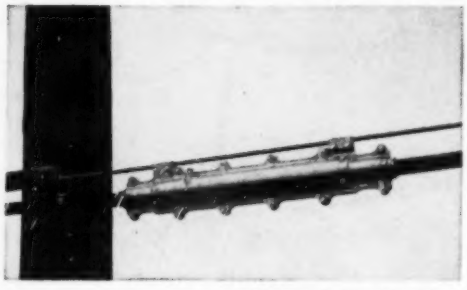
BOLTING VOICES TOGETHER

Adjusting casing over splice in polyethylene cable. Edges and ends are sealed with a new Butyl rubber compound that won't harden, dry out or lose adhesion even in extreme heat or cold.

More than ever, light, flexible polyethylene sheathed cable developed by Bell Telephone Laboratories is providing speedy answers to the demand for more telephone service.

But at thousands of splices, the sheath must be thoroughly sealed against moisture. Laboratories engineers developed a protective casing which is quickly and simply bolted in place. The edges and ends of the casing are *permanently* sealed with a new compound developed by Laboratories rubber chemists.

Now, economical polyethylene cable can be installed much faster and at lower cost. Here is another example of how Bell Laboratories continually finds ways to keep telephone service high in quality, while the cost stays low.

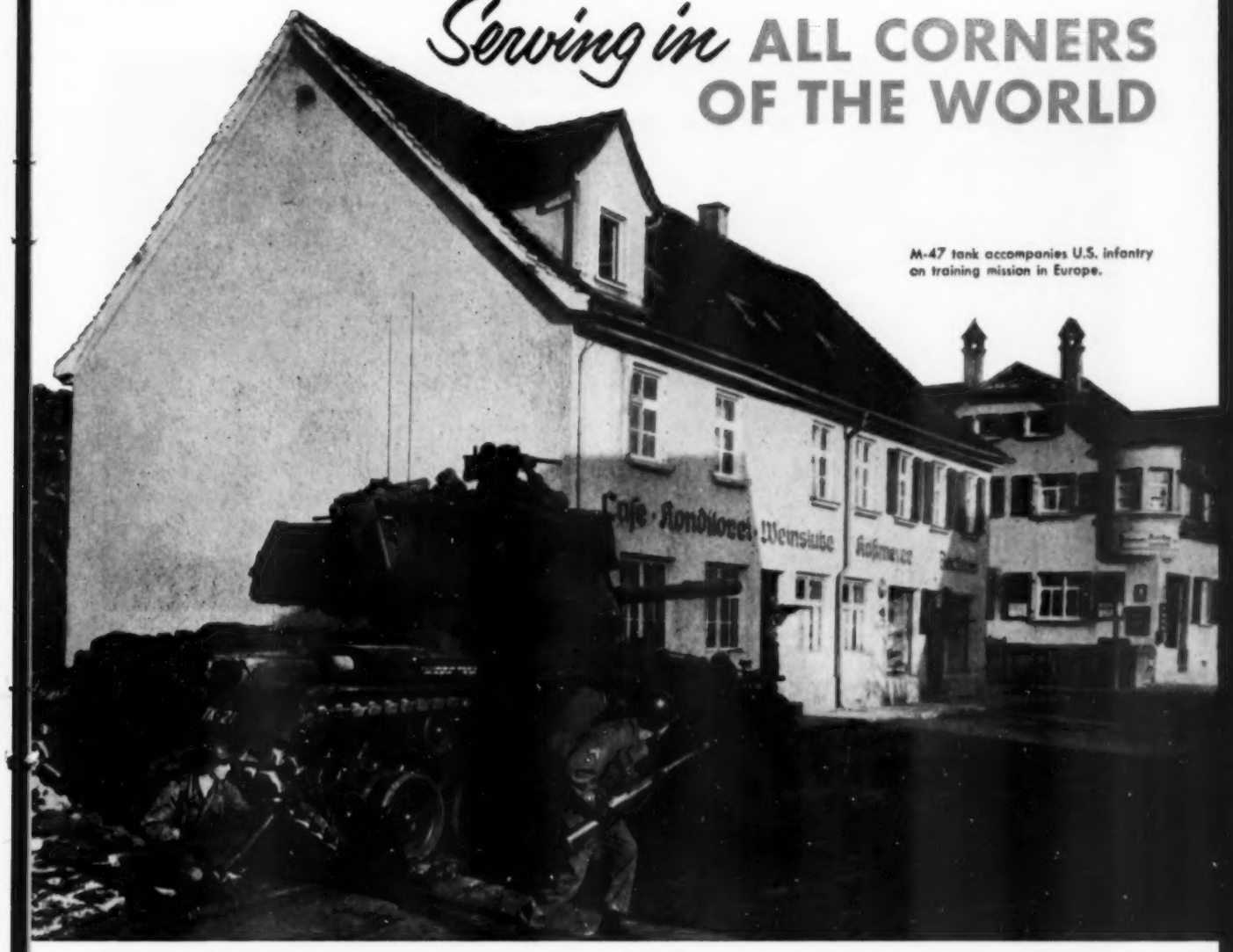


CLOSED CASING IN PLACE

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

Serving in ALL CORNERS OF THE WORLD



M-47 tank accompanies U.S. infantry on training mission in Europe.

ARMOR PLATE *for Ordnance*

BY AMERICA'S FOREMOST PRODUCER

Wherever peace and security are threatened by aggressors you will find armored equipment made in the U.S.A. standing guard. Engineering and metallurgical "know-how," combined with mass production techniques common to this country alone are building an arsenal of defense for all the world.

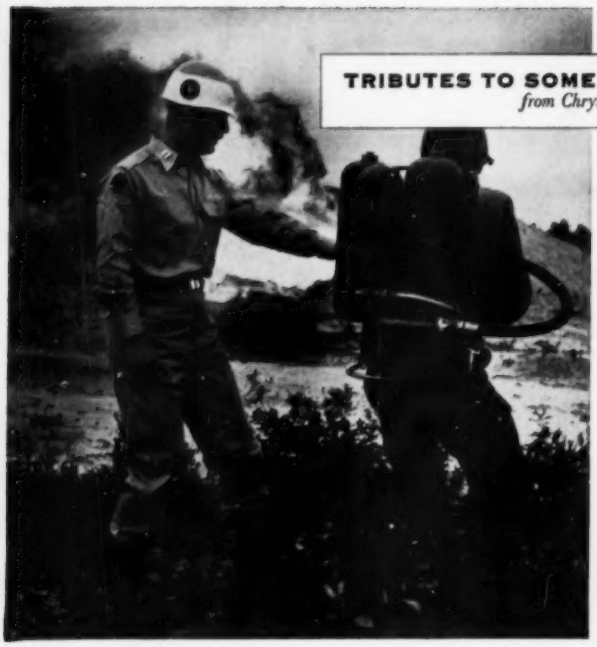
Consider armor plate for tanks. Serving as key producer and coordinator for Ordnance armor plate programs has been a Standard Steel Spring assignment for years. Our talents have contributed mightily to the design and production of many tank components. The flexible handling of our unexcelled manufacturing facilities has expedited shipment of an impressive tonnage of flat, formed, fully machined parts to all major tank producers. *This program will continue* until all who challenge the free way of life are made to realize the futility of attack.

Standard Steel Spring Division

ROCKWELL SPRING AND AXLE COMPANY

Armor Plate Office: **PENOBSCOT BUILDING, DETROIT, MICH.**

TRIBUTES TO SOME PEOPLE WE ALL LIKE:
from Chrysler Corporation



TYPICAL CAREER OFFICER is Captain Allen Snyder, U.S. Army. Snyder enlisted in 1940, served every enlisted rank, received a battlefield commission after heroic action on the island of Leyte in World War II. Now Faculty Chief of training, 9th Inf. Div., Ft. Dix, N.J., Captain Snyder here instructs a recruit in the use of the flame thrower.

ACTING OFFICER OF THE DECK Albert E. Kizis, Lt.(jg) U.S. Navy, directs a change of course on the bridge of the U.S.S. Tarawa. Kizis, a graduate of the University of Scranton, Pa., attended Officer Candidate School at Newport, N. J. Currently on a two year tour of duty, Kizis can ship over for additional duty as he chooses.

PHOTO BY PHILIPPE HALSMAN

BUCKLING ON GEAR AS HE GOES, Capt. Richard Davis races for his jet fighter during an alert "scramble" at McGuire Air Force Base. In two minutes, he'll scream into the air, carrying live ammunition just in case it's the "real thing." On the alert 24 hours a day, these skilled jet pilots are key men in the program of the Air Defense Command.

UNDER A BLANKET of heavy naval bombardment, Lt. Charles E. Mueller leaps from the mouth of an LVT amphibious landing craft, leading an assault against a fortified beach during air-ground problems at Marine Corps Schools, Quantico, Va. Only 23, Lt. Mueller is already a veteran of six years service, plans to do thirty.

THEIRS IS THE HARD-EARNED JOB OF COMMAND

The Regular Officer in the U. S. Armed Forces today, whether serving at home or overseas, is something unique in the military history of the world, and also in the history of his country.

By birth and instinct a citizen of a peace-minded country, his is the task of command of the toughest and most technologically intricate warfare the world has ever known. His is the job of leadership in morale and in maneuver of his fellow citizens who join him in peace time training or war time urgency. His is often the job of civilian, military, and even diplomatic command in occupied territories far from home.

There was a time when most officers were graduates of the traditional Academies. But today's massive manpower requirements draw much officer complement from OCS, and college ROTC training programs. And war time emergency has seen many capable men commissioned in the heat of battle, to fill the needs of frontline command.

Chrysler Corporation is proud to salute the Officers of the Armed Forces of America. Here they are on these pages, running your Army, commanding your ships, flying the missions that defend your shores. Take a good look at them. For they are the loyal men and women of America who help look after the hard daily business of guarding the country in which you live.

This message about people we all like is presented by your PLYMOUTH—DODGE—DE SOTO—CHRYSLER—DODGE "JOB-RATED" TRUCK dealers, and

CHRYSLER CORPORATION

Enjoy "Medallion Theatre"... dramatic entertainment for all the family... every week. CBS-TV. See your local paper for time and station.

by EDGAR A. GUEST

They are the ones, air, sea and land,
Trained to obey and to command;
Scholars of merit and degree,
Generals and admirals some to be,
Chosen as lads, deserving trust,
Willing to die, if die they must.

West Point, Annapolis are schools
Where honor's held by rigid rules.
This their high purpose and their plan,
To train the boy to be a man.
That done, to serve his country's need,
His comrades he'll be fit to lead.

They are our nation's chosen best,
Tested by every human test
For knowledge, courage, strength of will,
Devotion, patience, judgment, skill.
At first cadets, but every one
Men to command as time goes on.

Admirals, generals, captains all
Ready to answer duty's call
'Til peace shall come and war shall end,
On them for freedom we depend.
Men (in salute I raise my hand)
Trained to obey and to command.

If you would like a reprint of this poem, suitable for framing, write Chrysler Corp., Dept. RS4, 341 Massachusetts Ave., Detroit, Mich.

Copyright 1954 Chrysler Corporation

THE LIAISON OFFICERS for the defense advisory committee for women in the services leave the Pentagon with Lt. Col. Emily C. Gorman, deputy director of the WAC. Representing the Navy, Army, Marines and Air Force, these officers are typical of the many women who have voluntarily entered the armed forces, finding a rewarding career while making their special contribution to our defense.

FAST COAST GUARD RESCUE BOAT speeds victim to shore as Chief Bos'n John J. Gibbs, Commanding Officer of Rockaway Lifeboat Station in New York, supervises resuscitation. Under the Treasury Department in peace, the U. S. Coast Guard performs many vital functions of rescue, patrol, and law enforcement on the high seas.

This advertisement appears in LIFE *January 18, 1954*

NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD

MACH

BUSTER!

First of the true tri-sonic fighters, the new F-100 Super Sabre exceeds Mach 1 in normal, level flight... flying faster than the speed of sound.

MACH (pronounced "mock") is a term you'll be seeing more and more since it is the only really accurate way of evaluating jet plane speeds. The need for this special standard of measurement is due to the fact that the speed of sound varies with changes in temperature and altitude. At sea level, for instance, sound travels at speeds ranging from 735 MPH at an air temperature of 60° to 800 MPH at 100°. However, using the Mach numbers, a jet traveling at Mach 1 is flying at the speed of sound, no matter at what altitude or temperature. Far advanced beyond any fighter now in production, the F-100 Super Sabre was designed and built by North American to meet our nation's need.

Engineers of vision... men who appreciate a challenge, are wanted at North American. If you are an engineer looking to the future, write North American, Los Angeles 45, California.

Organization, Facilities and Experience Keep

North American Aviation, Inc.

Years Ahead in aircraft... guided missiles... electronics... atomic energy... research and development

Precision Deep-Drawing
speeds - simplifies ordnance production
Precision deep-drawing as perfected by Eastern Tool & Mfg. Co. speeds production and cuts costs in the manufacture of many ordnance items. Illustrated here are a few shapes and sizes in copper, steel and aluminum from our current production.
Write for more information.
Eastern Tool & Mfg. Co.
Belleville 9, N. J.

Announcing...

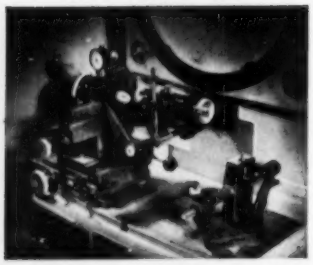
a new method for analyzing gears by optical gaging

Gear analysis can now be done *visually* by optical gaging methods. With the new OGP Gear Analyzer you can check involute spur gears *functionally and analytically* under simulated operating conditions. A single chart-gage can be used for any gear with the same pressure angle to inspect, analyze, and gage the following elements:

- Involute Profile.
- Fillet Interference (or Clearance).
- Outside Diameter.
- Root Diameter.
- Pitch Diameter.
- Backlash (effective tooth thickness at Standard P.D.), by:
  - (1) Center distance
  - (2) "Slap between teeth"
- Tooth-to-Tooth Spacing—(Circular Pitch).
- Modified Tooth Form.
- Tapered Teeth.
- Tooth Crowning.
- First and Last Contact Points.
- Off-Axis Teeth—(asymmetrical).

Complete analysis of "running conditions" can be made, even when gear operates with backlash.

Write for the details on this fast, accurate gear checking method.



OGP Gear Analyzer and Set-Master for gears ⅛" to 5½" P.D. Requires no master gear.

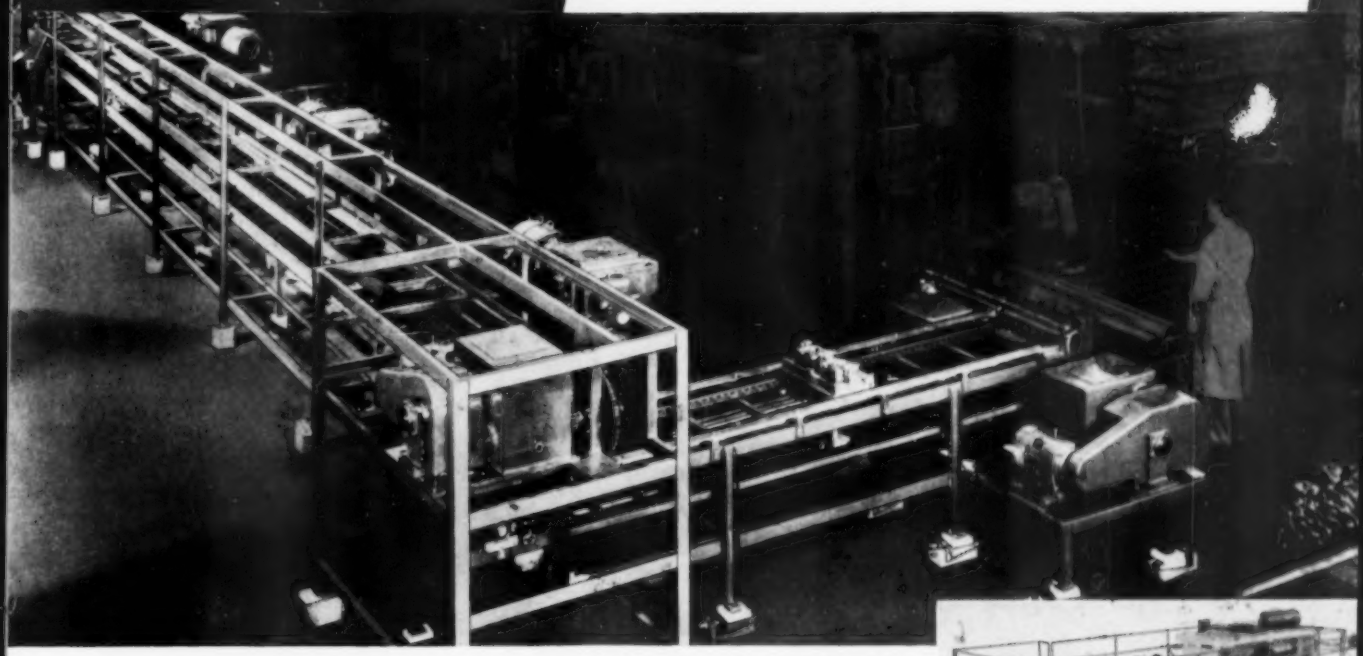
OPTICAL GAGING PRODUCTS INC.

26 FORBES STREET, ROCHESTER 11, N. Y.

SPECIALISTS IN PROJECTION GAGING

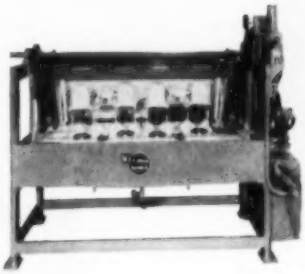
Now Available

A Special AUTOMATION EQUIPMENT Designing and Building Service



▲ Many progress-thru type machine tools employ special conveyors to return the work-holding fixtures to the loading end of the machine, as shown above. Barnes conveyors are designed to do this work automatically, in cycle with the machine, to greatly reduce work-handling costs.

▲ Another Barnes unit designed to speed work-handling is this special two-carriage automatic loader and unloader for handling heavy railroad axles before and after machining. Smooth, accurate traversing of the carriages is accomplished with a special electrical slow-down circuit.



▲ This special semi-automatic testing machine was developed by Barnes to test for leaks in automotive power steering castings. It handles four workpieces per cycle. Except for loading and unloading, all operations are performed automatically.

COMPLETE facilities are now provided by the Process Equipment Division of the W. F. & John Barnes Company for the designing and building of standard and special automation equipment. Widely experienced in this specialized field, Barnes have developed many units, both large and small, which are now successfully and profitably cutting work-handling costs and increasing production output in hundreds of industrial plants. The three units illustrated are typical of the broad range and variety of thousands of methods and processes developed by the Barnes' Process Equipment Division.

Here at Barnes, you'll find the varied engineering and creative skills, plus over 75 years of machine building background, to help you solve many troublesome production problems. And because all planning, engineering, and manufacturing efforts are closely coordinated, you have available a complete *Automation Equipment Service* from one convenient source.

ASK FOR AN ANALYSIS OF YOUR WORK-HANDLING METHODS

Find out how these unique creative and specialized resources can help you cut costs. Your problem will be given expert and individual attention.

GET THIS *Free* BOOKLET

Write today for your copy of "Co-ordinated Creative Engineering and Manufacturing" — a 32-page booklet crammed with cost-cutting *Automation Equipment* ideas.

W. F. & JOHN BARNES

W. F. & JOHN BARNES COMPANY

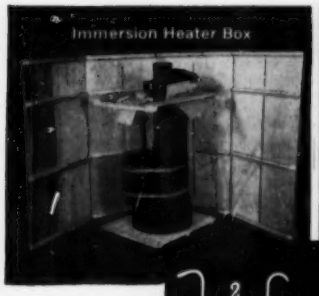
PROCESS EQUIPMENT DIVISION

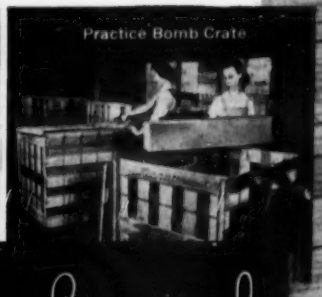
308 SOUTH WATER STREET • ROCKFORD, ILLINOIS

Everyday
more and more service shipments
go **WIREBOUND**

An ever increasing number of suppliers are taking advantage of improved Military and Federal specifications so that they may obtain the benefits of Wirebound containers for Armed Service shipments. They've found Wirebound box manufacturers well qualified to supply containers that meet government requirements for parts, equipment, over-packs, food and hundreds of other uses. Wirebound plants throughout the country are up-to-date on Armed Service shipping specifications and have the experience, technical know-how and testing facilities to produce the best container for each use. Why not check with your Wirebound supplier or write for full information!

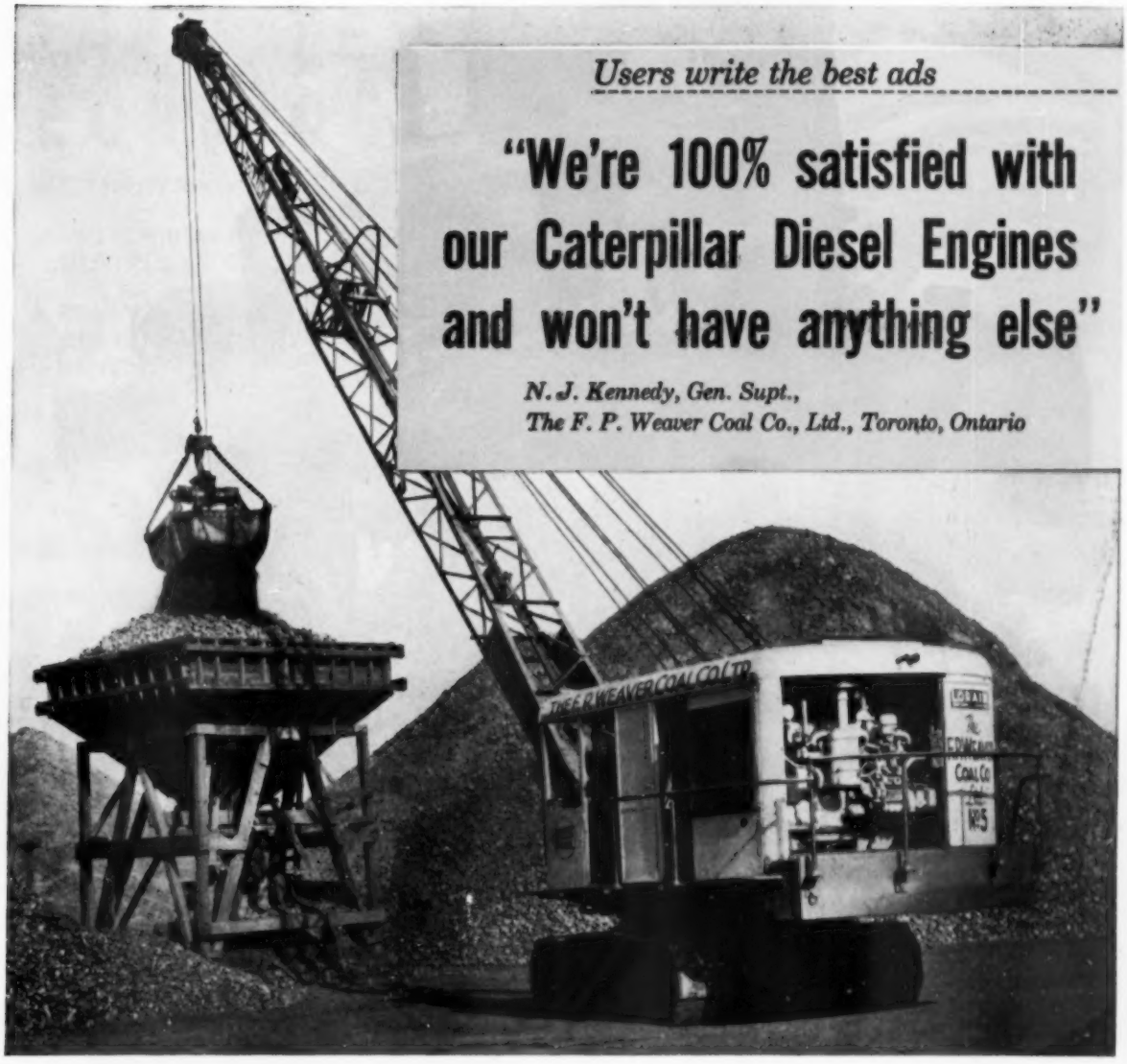
Wirebound Box Manufacturers Association
Room 1163, 327 South LaSalle Street, Chicago 4, Illinois





Wirebound
BOXES & CRATES

75 WIREBOUND BOX PLANTS are ready to serve you!



Users write the best ads

"We're 100% satisfied with our Caterpillar Diesel Engines and won't have anything else"

N. J. Kennedy, Gen. Supt.,
The F. P. Weaver Coal Co., Ltd., Toronto, Ontario

You won't hear a statement like that from a user unless his equipment has done a standout job for him. Mr. Kennedy speaks from firsthand experience with three Cat* D13000 Engines in Lorain cranes.

One of them powers this 1¾-yard clamshell, used for unloading vessels and rehandling coal. In 14 years on this dusty job, the D13000 totaled some 38,000 working hours. In the other two Lorains, one D13000 has accumulated over 40,000 hours and the second over 36,000 hours.

This owner went on to say, "Economy and dependability are the main reasons for my satisfaction." When you consider that Caterpillar Diesels can use low-cost No. 2 furnace oil without loss of efficiency and without fouling, that can mean a substantial saving in any operation.

These rugged yellow units save you money other ways. Long life and dependability are engineered into them. They stay on the job, day after day, with a minimum of maintenance and down time. And your Caterpillar Dealer is nearby for prompt, on-the-spot service.

Standardization on Caterpillar power pays off handsomely—ask your dealer for *proof*. Engines and electric sets, in 12 sizes for every purpose, range up to 500 HP and 315 KW. He can furnish these money-saving units for replacement, and leading manufacturers can supply them in the machines they build. Get the full *facts* today!

CATERPILLAR, Peoria, Illinois.

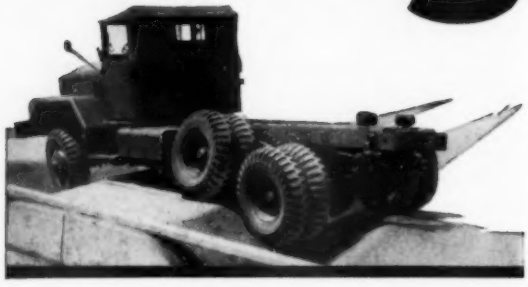
CATERPILLAR*

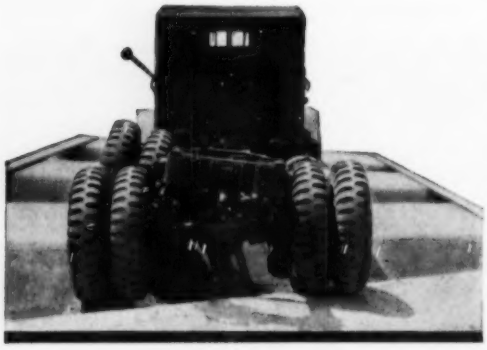
*Both Cat and Caterpillar are registered trademarks—®

NAME THE DATE... YOUR DEALER WILL DEMONSTRATE

flexibility

Flexibility to meet the demands of any military situation . . . flexibility to travel any terrain without power loss—that's the performance International Harvester builds into 5-ton trucks for the Armed Forces.





The same engineering, research and manufacturing know-how that have built our reputation for quality, also stand behind our military production. Rigid tests conducted at International Harvester proving grounds in Fort Wayne, Indiana and at Phoenix, Arizona *prove that production!* We know these trucks have extra power and sturdiness always on the ready.

The twist course, putting an International 5-ton 6 x 6 through the paces, is only one of many tests used to determine the amount of punishment these trucks can take. Internationals are proved before they start . . . will set the pace wherever, whenever duty calls.

INTERNATIONAL HARVESTER Chicago 1, Illinois

Builders of products that pay for themselves in use . . .
International Trucks • McCormick Farm Equipment and Farmall Tractors
Crawler Tractors and Power Units • Refrigerators and Freezers

A NEW TERMINATION TECHNIQUE FOR . . .

- COMPUTERS
- SWITCHBOARDS AND INSIDE PLANT EQUIPMENT
- RELAYS, SWITCHES, AND MULTI-CIRCUIT COMPONENTS

AMP

FLAT TAPER TAB RECEPTACLES

If you are concerned with the wiring of close spaced equipment, investigate the new AMP Solderless TAPER TAB RECEPTACLE for flat relay or switch tabs shown at right. It is self locking when installed on a male tab with matching $3\frac{1}{2}^{\circ}$ taper, yet can be removed and reconnected any number of times without solder or special tools. These terminals are supplied on reels in continuous strip. Customer crimps them on wires using AMP automatic machines at speeds up to 4,000 per hour!

Performance of these miniature connectors meets exacting requirements for millivolt drop, corrosion resistance, and vibration. They are suited for critical low level circuits or power circuits up to several amperes.

Write to AMP Electronics Division for complete information concerning AMP TAPER TAB RECEPTACLES . . . you will receive data and samples by return mail.

PHOTO SHOWS AMP SELF LOCKING TAPER TAB RECEPTACLES BEING APPLIED TO MATING TABS ON A STEPPING SWITCH. LOCKING ACTION GIVES MAXIMUM ELECTRICAL AND MECHANICAL SECURITY . . . CONNECTIONS ARE SUITABLE FOR CRITICAL LOW LEVEL CIRCUITS.

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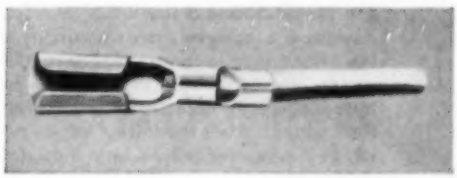


AMP

AIRCRAFT-MARINE PRODUCTS, INC.

2100 Paxton Street, Harrisburg, Pa.

Aircraft-Marine Products of Canada, Ltd.

1764 Avenue Rd., Toronto 12, Ontario, Canada

AMPEX

MAGNETIC RECORDERS

The most complete line of data tape recorders

AMPEX has applied magnetic tape recording to more varied problems in research, testing and control than any other manufacturer of tape equipment. To meet specific demands for broad frequency response, precise timing, extreme tape stability, high shock resistance and reliable transient accuracy, Ampex has built machines of a wide variety of designs. And from this experience has come this line of proven magnetic recorders:

F-M CARRIER TYPE RECORDER — MODEL 306

Explosions, shock waves, geophysical data and other highly transient phenomena can be recorded on the Model 306 with excellent "instantaneous" accuracy. Because the machine uses an fm carrier to modulate the signal, the accuracy of the recording is unaffected by minor tape imperfections.

Also, the Model 306 is able to record the vast majority of all mechanical occurrence, since it covers the extremely useful frequency range from 5000 cycles/sec. down to zero (D.C.).

OPTIONS: *One to 14 tracks*
Rack, console or combination mounting
Record and playback, record only or playback only

WIDE RANGE DIRECT RECORDER — MODEL 307

With a frequency response from 100 to 100,000 cycles per second, the Model 307 is particularly suited to steady state data occurring over a wide range of frequencies. The 307 has had extensive application in fm-fm telemetering, sharing this field with the Model 500 described below.

OPTIONS: *Same as Model 306*

PULSE WIDTH RECORDER — MODEL 303

This model can record any type of phenomena that lends itself to pulse width coding. Pulses can range from 60 to 1000 microseconds and will be accurate in duration to closer than 2 microseconds. Since each track on the machine may record commutated data consisting of many channels, it is possible to record hundreds of parallel data channels on one tape on a Model 303 machine.

OPTIONS: *Same as Model 306*

COMBINATION RECORDERS — MODELS 309, 311, etc.

Special Ampex Data Recorders can incorporate combinations of the heads and electronic circuitry of the 303, 306 and 307. Thus the parallel tracks on the same combination recorder might have the widely differing characteristics of each of those models. For example, on its parallel channels such a recorder might have an overall frequency response of 0 to 100,000 cycles/sec.

OPTIONS: *Same as Model 306 (but 2 or more tracks)*

"LOW FLUTTER" WIDE RANGE RECORDER — MODEL 500

The Model 500 is a four-track, two-speed magnetic tape recorder designed to achieve extreme stability of tape motion while recording information in the frequency range between 100 and 100,000 cycles. Thus it is able to record fm-fm telemetering data without introducing any objectionable data error from small variations in tape speed. It has the lowest known flutter and wow characteristics of any tape recorder — less than 0.1% peak-to-peak by RDB standards.

Console mounting only
Four tracks only

For specifications and other information, write Dept L-1535

Series 300 data recorder in rack mounting.

Series 300 data recorder in console mounting. Rack mounting of portions of the electronic components may be necessary on multi-track console mounted recorders.

Ampex Model 500 Recorder

AMPEX CORPORATION

934 Charter St., Redwood City, California

BRANCH OFFICES:
New York, Chicago, Atlanta, San Francisco and College Park, Maryland (Washington, D. C., area)

DISTRIBUTORS:
Radio Shack, Boston; Bing Crosby Enterprises, Los Angeles; Southwestern Engineering & Equipment, Dallas and Houston; Canadian General Electric Company in Canada.

AMPEX

MAGNETIC RECORDERS

This trade mark on rockets, shells, fuzes

and other ammunition metal components
assures the armed forces of highest quality,
delivery as promised and fair price.

HECKETHORN MANUFACTURING AND SUPPLY COMPANY
LITTLETON, COLORADO

Contractors to the United States Armed Forces for Rockets, Shells, Fuzes, Research and Development

DO *Your Products* FIT INTO THIS PICTURE?

Metal stampings have been the specialty of G. P. & F. for over 73 years. The illustrations above show just a few typical examples of contract parts we make for hundreds of customers. If you use deep drawn or stamped metal parts in your products, the chances are good that we have the facilities to meet your requirements. When you think of G. P. & F., think of over 1000 skilled people . . . 15 acres of production facilities . . . 293 deep draw and stamping presses . . . 97 welding machines . . . and a complete tool and die department.

G. P. & F.

Stamping • Drawing • Forming
Galvanizing • Welding
Lead Coating • Spray Finishing
Vitreous Enameling • Fiberglas

GEUDER, PAESCHKE & FREY CO., 1327 W. St. Paul Ave., Milwaukee 1, Wis.

LARGE SIZES AND INTRICATE SHAPES CAN NOW BE FORGED

The press forgings produced by Cameron approach for the first time the broad field of intricate shapes and patterns that have been limited heretofore to steel castings. Thus, the many manufacturing advantages of steel forgings are made more widely available. These advantages include controllable grainflow characteristics and a uniformly high quality, free from internal defects such as porosity and inclusions.

The Cameron forging process opens the door to a great many design features which will aid in producing equipment of greater utility and at a lower cost in manpower and material.

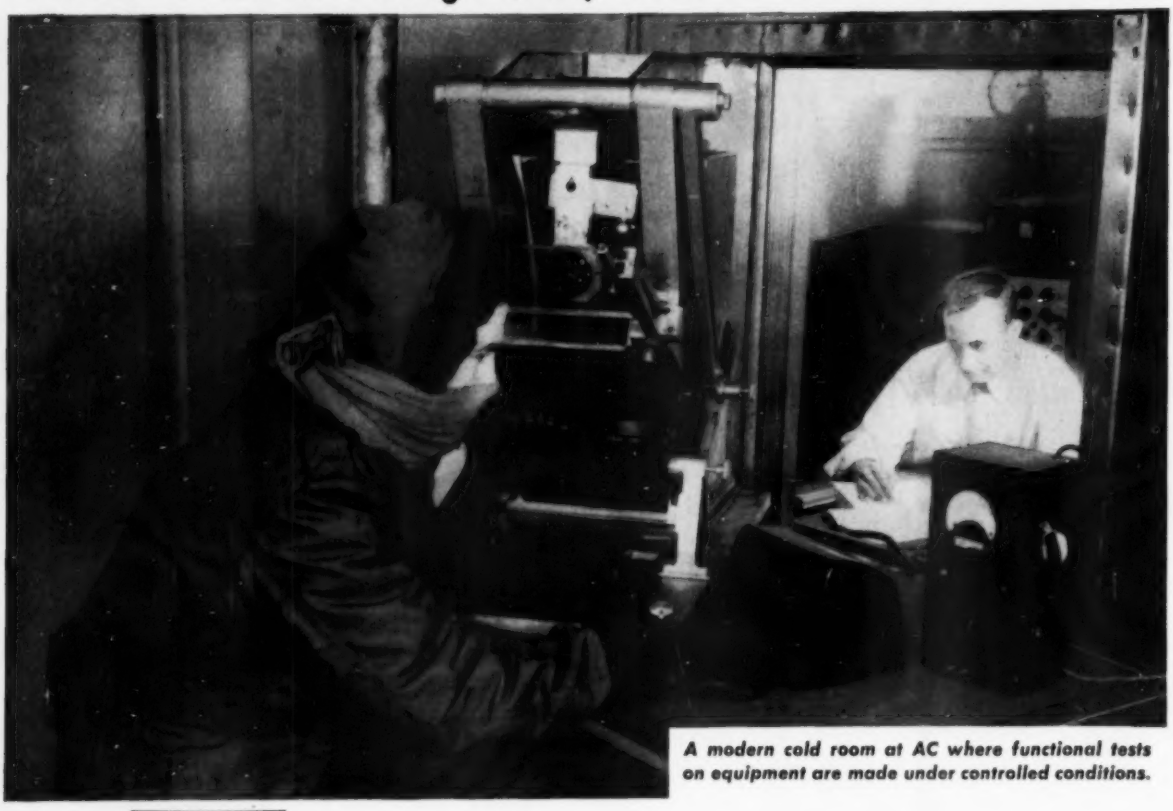
FORGE AND ORDNANCE DIVISION

Cameron

IRON WORKS, INC.
HOUSTON, TEXAS

Scale — one foot

DEFENSE PRODUCTS *of High Quality at Low Cost* DELIVERED ON TIME



A modern cold room at AC where functional tests on equipment are made under controlled conditions.

GM GENERAL MOTORS GM GOOD MANAGEMENT

AC KNOW HOW

Giving Defense Products the "*Third Degree!*"

In the AC plants will be found not only the latest machine-tool equipment of every description, but also the very newest and finest in testing facilities—

- complete testing laboratories
- electronic computing brain
- high-altitude test chambers
- vibration-testing equipment
- sound rooms
- cold rooms—to 100° below zero F
- high-temperature rooms
- humidity chambers
- darkrooms
- screened rooms for elimination of outside electrical interference
- standards rooms for maintaining basic standards for electrical test equipment

Years of experience in producing complex electro-mechanical devices for the Armed Forces makes AC a logical choice to engineer, develop and build any new devices of a similar nature which may be under consideration by your organization.

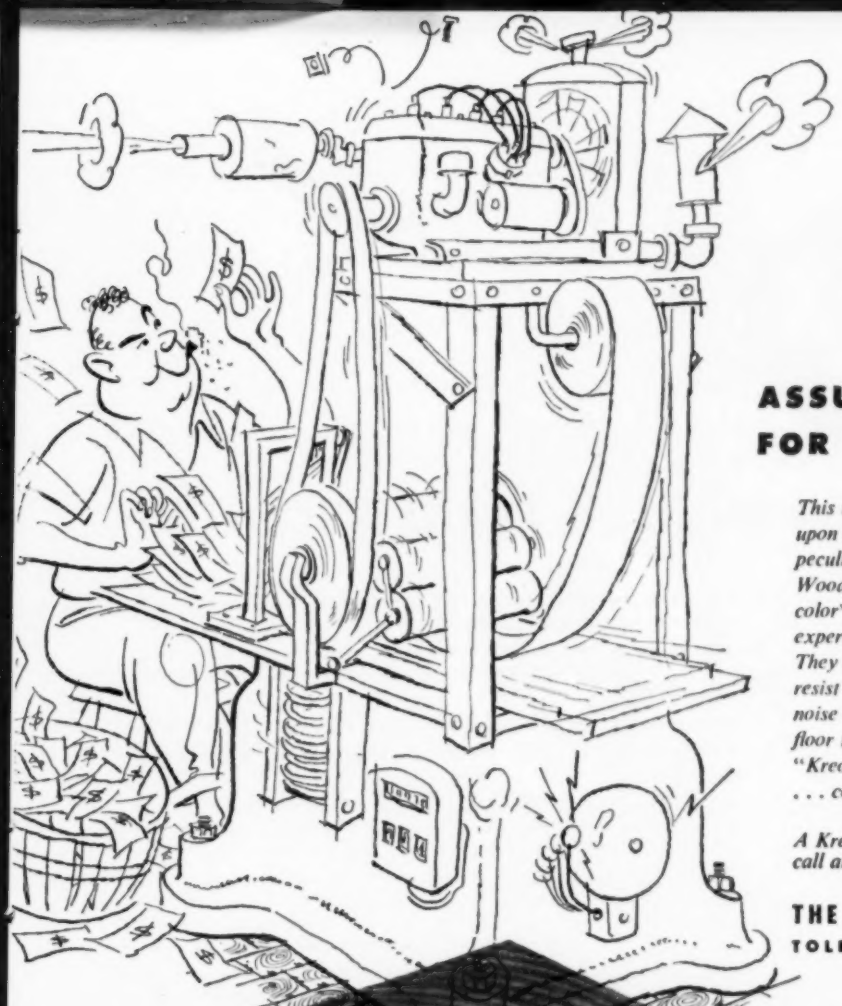
AC is now producing—in volume—these complex, high-precision, electro-mechanical devices for the Armed Forces:

- "A" Series Gun-Bomb-Rocket Sights
- A-1A Bombing Navigational Computers
- T-38 Fire Control System for the Skysweeper

★

Would you like employment offering travel and educational opportunities? We invite graduate electronic, mechanical, servo and field service engineers to write our Salary Personnel Department for booklet "You and Your Future."

AC SPARK PLUG DIVISION GM GENERAL MOTORS CORPORATION
FLINT, MICHIGAN

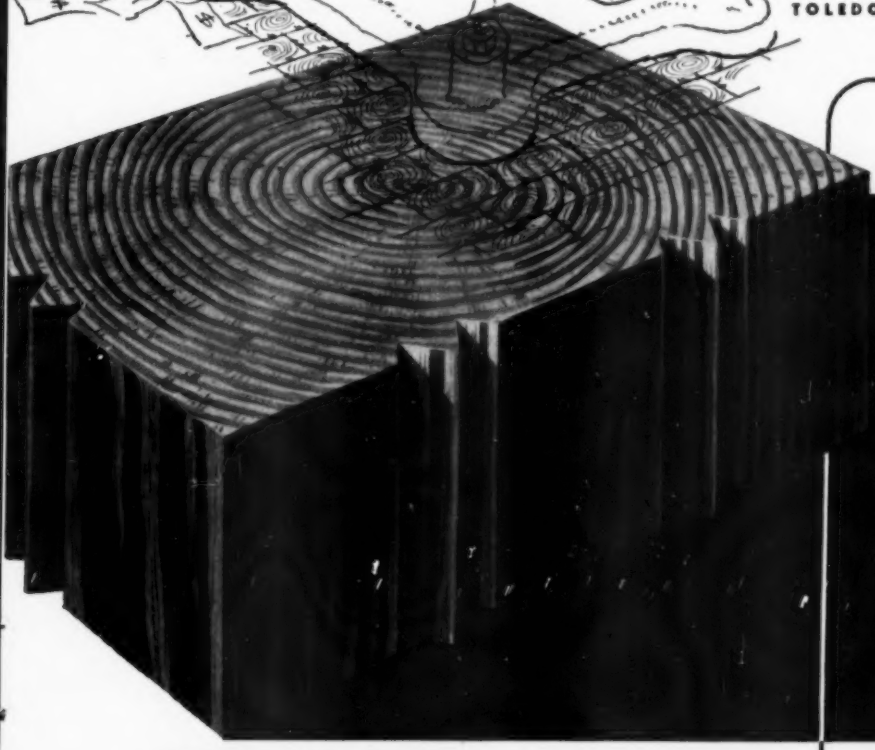


ASSURES FIRM FOUNDATION FOR MACHINES*

This type of a "money-maker" is frowned upon by our government (it has its own peculiar ideas about money makin') but a "Kreolite" Wood Block Floor is a "horse of a different color" . . . many printers and manufacturers have experienced the money making qualities of these floors. They assure a firm foundation for machines . . . resist and absorb terrific weights, pressures, blows, noise and vibration . . . thus providing a comfortable floor to work and walk on. Coated with "Kreolite Jennite" it is dust, skid and spark-proof . . . cooler in summer and warmer in winter.

A Kreolite Wood Block flooring expert will call at your request.

THE JENNISON-WRIGHT CORPORATION
TOLEDO 9, OHIO • *30 Nation-Wide Offices*



SPECIFY KREOLITE . . . *Hundreds of millions of square feet used by leading industries since 1911*

1 Comfortable to work over . . . easy under foot.
2 Durable . . . Withstands heavy abuse.
3 Resilient . . . protects dropped tools and parts.
4 Quick to install . . . can be used immediately.
5 Assures firm foundation for machines.*
6 Easy to replace . . . in sections or by units.
7 Affords low maintenance cost. ½ of 1% in 20 years.
8 Offers low tractive resistance . . . easy to truck over.
9 Dustless . . . protects bearings and finished product.
10 Absorbs noise.
11 Lessens vibration.
12 Insulates against heat and cold.
13 Spark-proof, skid-proof, safe . . . with "Kreolite Jennite" filler.
14 Easy to provide for conduits or cables.
15 Eliminates glare from reflected light . . . decreases eye strain.

KREOLITE WOOD BLOCK FLOORS

ALSO "KREOLITE" RAILROAD CROSS & SWITCH TIES • INDUSTRIAL TRACK TIES • COAL TAR PRODUCTS • BRIDGE & DOCK LUMBER

N·A·X
ALLOY STEELS

MODERN STEELS for MODERN TRANSPORTATION

- **N-A-X HIGH-TENSILE** steel—a low-alloy high strength structural steel used to reduce weight and increase life of your product.
- **N-A-X AC 9115** steel—for gas turbines and similar products requiring strength of material when operated at higher than normal temperatures up to 1000°F.
- **N-A-X 9100** series—alloy steels for carburizing and heat treated parts.

With these three N-A-X ALLOY STEELS, we offer time proven products to economically serve you.

N-A-X HIGH-TENSILE is 50% stronger than mild carbon steel with high notch toughness. Has excellent cold forming and welding properties and greater resistance to atmospheric corrosion and abrasion.

N-A-X AC 9115—a steel easily fabricated and welded by any method, maintains high strength at elevated temperatures up to 1000°F. When protected against high temperature oxidation by proper coatings, it is a worthy alternate for the higher-alloy stainless type steels for this application.

N-A-X 9100 series—a series of alloy steels with the alloying elements constant within an established range, with carbon varied to suit the hardenability and hardness desired. An outstanding carburizing steel.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division Ecorse, Detroit 29, Mich.

NATIONAL STEEL CORPORATION

an outstanding achievement

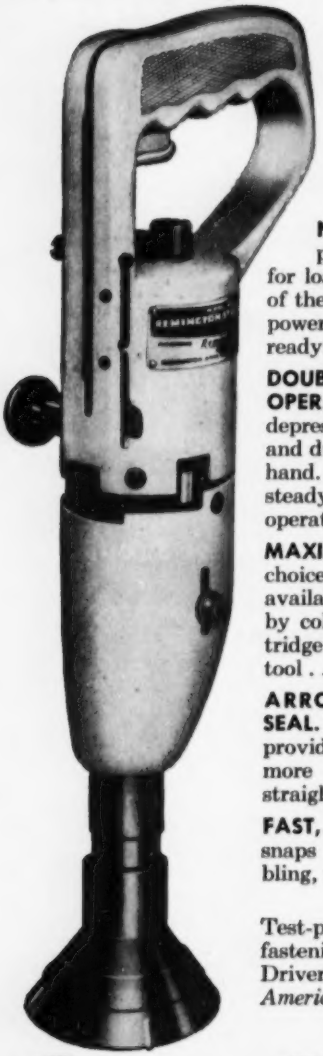
over 1,500,000 shells without a ballistic failure.

The coordinated production of KWIKSET Defense Products and KWIKSET'S subsidiary, West Coast Loading Corporation, has made possible the manufacturing and loading of over 1,500,000 60-mm mortar illuminating shells for the defense of our nation.

Kwikset Defense Products

Anaheim, California

MODEL 450 REMINGTON STUD DRIVER



—the ONLY powder-actuated fastening tool with ALL these advantages—

NO ACCESSORIES REQUIRED. No separate parts needed to control power, none required for loading—nothing to lose or break. Just a twist of the wrist opens the Model 450. Insert stud and power cartridge as a unit . . . close and you're ready! Whole job takes seconds.

DOUBLE-SAFE—REQUIRES *BOTH* HANDS FOR OPERATION. A separate safety lever must be depressed and *held* that way with one hand before and during squeezing of the trigger with the other hand. Safe, two-handed operation holds the tool steady. Two *additional* safety devices prevent operation except in proper fastening position.

MAXIMUM POWER RANGE. You get a wide choice of power in Remington cartridges. They're available in six different loads, each clearly marked by colored plastic heel caps. The 32 caliber cartridge gives you extra power in this medium-duty tool . . . helps you speed all types of fastening jobs.

ARROW-STRAIGHT DRIVING—PERFECT GAS SEAL. Long heel cap on all Remington cartridges provides tight gas seal . . . gives the Model 450 more power. Assures controlled, consistently straight driving.

FAST, POSITIVE EJECTION. Exclusive ejector snaps fired case out of tool instantly—no fumbling, no tools needed.

• • •

Test-proved to be the world's finest and speediest fastening system, the Model 450 Remington Stud Driver is made by Remington Arms Company, Inc., *America's oldest sporting arms manufacturer.*

"If It's Remington—It's Right!"

Remington DU PONT

Listed & Approved by Underwriters' Laboratories, Inc.

NEW, FREE BOOKLET shows you a hundred different ways the Model 450 Remington Stud Driver can speed *your* construction fastening. Packed with illustrations, it tells you where and how this tool can save time, reduce fatigue and cut costs. Send in the coupon for your copy.

—MAIL THIS COUPON TODAY—

Industrial Sales Division, Dept. O-3
Remington Arms Company, Inc.
939 Barnum Ave., Bridgeport 2, Connecticut

Please send me my free copy of the new booklet showing how I can cut my fastening costs.

Name.....

Position.....

Firm.....

Address.....

City.....State.....

ATOMIC ENERGY

NEW SYNCHROTRON

The Atomic Energy Commission has approved design and construction at Brookhaven National Laboratory of an ultra-high-energy particle accelerator for nuclear research. The new machine, an alternating-gradient synchrotron, will be designed to produce beams of protons of energies ranging up to twenty-five billion electron volts.

The alternating-gradient synchrotron will use a series of alternate strongly converging and diverging magnetic fields to confine a proton beam in a tube of relatively small cross section. This focusing effect allows the production of high-energy beams with smaller electromagnets and related equipment than would otherwise be possible.

The cost of design and construction of the new accelerator is estimated at $20,000,000. Design work will start at Brookhaven in the near future, and it is expected that the machine can be completed in five to six years. Once in operation, it will be available to scientists wishing to collaborate in Brookhaven research programs or to carry out independent programs.

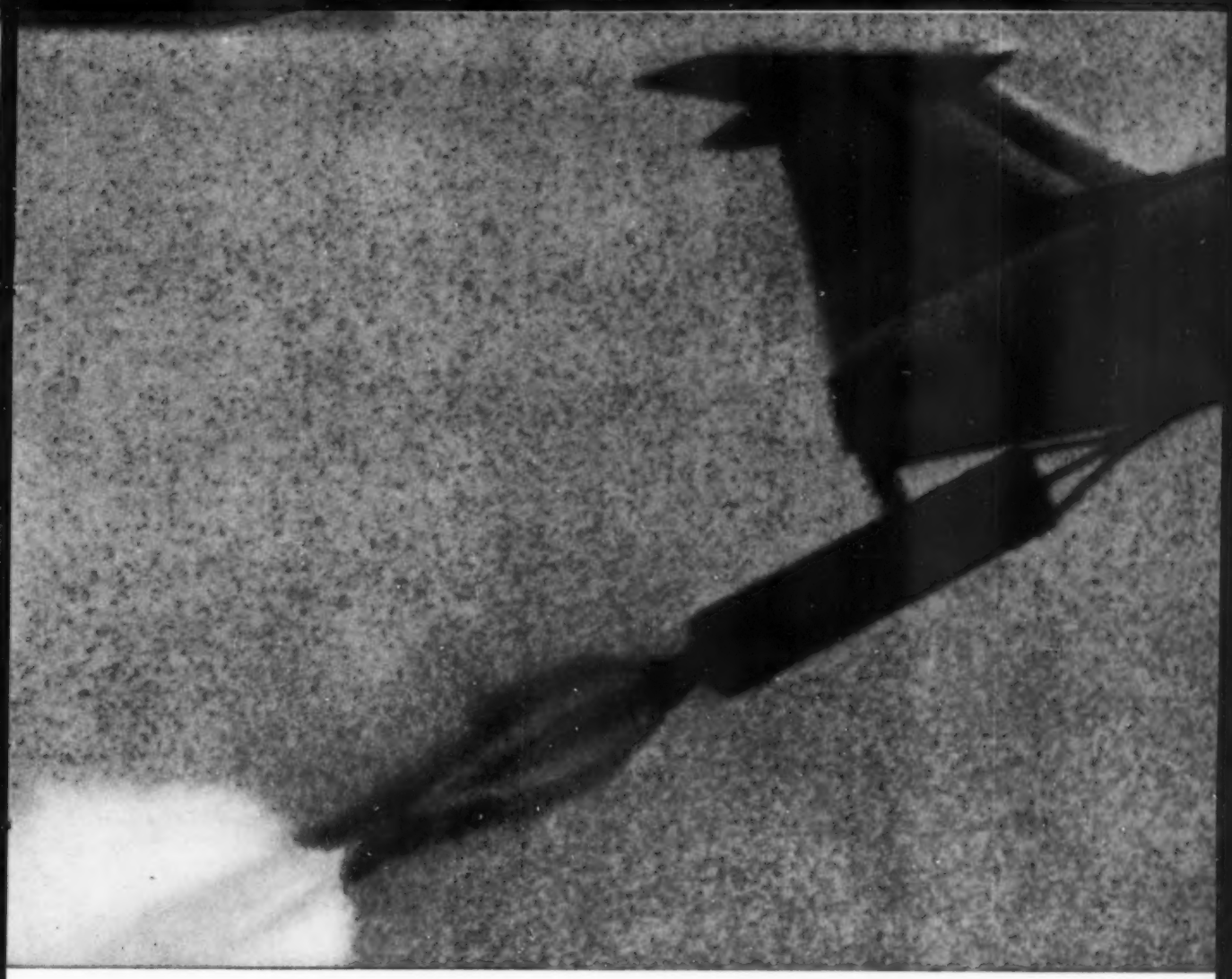
The most powerful accelerator now in operation is the Brookhaven cosmotron, which has accelerated protons to energies of 2.3 billion electron volts. The bevatron, under construction at the University of California Radiation Laboratory at Berkeley, is expected to accelerate particles into the five to seven billion electron-volt range. By providing particles with energies as high as twenty-five billion electron volts, the Brookhaven alternating-gradient synchrotron is expected to contribute important new knowledge of the fundamental nature of matter.

Brookhaven National Laboratory, a research center equipped with facilities which no single university could afford to build or support, is operated for the AEC by Associated Universities, Inc., a corporation formed by nine northeastern universities. The institutions represented are: Columbia University, Cornell University, Harvard University, Johns Hopkins University, Massachusetts Institute of Technology, Princeton University, University of Pennsylvania, University of Rochester, and Yale University.

"JUNIOR" ACCELERATORS

A powerful new tool of nuclear research—Stanford University's billion-volt, super-high-frequency, 200-foot-long electron linear accelerator—is going to be made in junior sizes for cancer therapy and inspection of industrial products.

The "toned-down" accelerators will be manufactured and sold by the X-ray de-



moment in history

You are looking at 1/1000 of a second in the history of aviation. It occurred at a fraction past 4:31 p.m. on January 20, 1949.

This was the Zero moment which marked the official launching of the first successful pilotless bomber to be approved by the U.S. Air Force—the Martin B-61 Matador.

The picture is historic for a very significant reason: it records the tradition-shattering payoff of an entirely new development in the aircraft industry, known as Martin Systems Engineering. This is a science and a method of developing spaceborne systems as total solutions of Operations problems.

The Martin Matador is far more than the thing you glimpse here. Behind it is an integrated network of facilities designed to give this important new weapon simplicity of operation and extreme mobility. These components add up to the total solution of one of the most formidable security problems of our time.

They also add up to one of today's most important developments: the full story of Martin Systems Engineering.

You will hear more about Martin!

Martin AIRCRAFT

THE GLENN L. MARTIN COMPANY
BALTIMORE · MARYLAND

CLEVELAND CONTAINERS

METAL END FIBRE CANS FOR UNIT PACK AND INTERMEDIATE PACKING . . . For both MILITARY and CIVILIAN USES.

SAVE TIME in packaging . . . EXPEDITE repairs by having available spare parts needing frequent replacement.

These cans provide a continuous barrier and permit the reduction or elimination of preservatives and internal wraps.

★ ★ ★

MIL-C-12147(A) MIL-C-5405 MIL-C-12804

Spare parts and supplies packaged in containers made to MIL-C-12147(A) meet all the requirements on Method IA and Method II Packaging. The reduction in cost from your present method of packaging may be substantial.

Fibre container packs are approved and in current use by most of the technical branches of the Government. The uses in civilian applications are becoming more numerous every day.

We supply a complete service, from the design of the container to furnishing closing equipment, which is available on a rental basis.

The CLEVELAND CONTAINER Co.
6201 BARBERTON AVE. CLEVELAND 2, OHIO
• All-Fibre Cans • Combination Metal and Paper Cans
• Spirally Wound Tubes and Cores for all Purposes

PLANTS AND SALES OFFICES: Cleveland, Chicago, Detroit, Memphis, Plymouth, Wisc., Ogdensburg, N. Y., Jamesburg, N. J., Los Angeles • ABRASIVE DIVISION at Cleveland. SALES OFFICES: Grand Central Terminal Bldg., New York City; Washington Gas Light Bldg., Washington, D. C.; West Hartford, Conn.; Rochester, N. Y.

Cleveland Container Canada, Ltd.: PLANTS AND SALES OFFICES: Toronto and Prescott, Ont. • SALES OFFICE: Montreal.

partment of General Electric Company under a 10-year agreement with the university. They should be on the market within the next few years.

General Electric engineers will spend a year at Stanford studying the design and construction of linear accelerators, including a pilot medical accelerator now being built. This 6-million-volt, 6-foot machine will be installed at Stanford School of Medicine in San Francisco, where radiologists plan to use it against deep-seated cancer by the end of 1954.

Stanford-designed accelerators "shoot" electrons in a straight line through a copper tube at almost the speed of light —approximately 186,000 miles a second.

The electrons ride on microwaves produced by klystrons, the most powerful vacuum tubes made. High-voltage X-radiation can be produced when a metal target is placed in the beam's path.

This radiation has advantages over lower-voltage X-rays in treating deep-seated cancer, according to various medical reports. More of the high-energy radiation reaches the depths of the body, less of it affects the skin. Numerous uses for the linear accelerators in industrial radiography are also likely, such as X-raying metals for flaws. The 6-million-volt accelerator being built will pave the way for others of lower and higher voltages. It is expected this may open new possibilities for reducing the cost of high-voltage X-ray apparatus for both medicine and industry.

MEDICAL FELLOWSHIPS

Eight fellowships in industrial medicine will be offered by the Atomic Energy Commission for the 1954-1955 academic year. The fellowship program, begun by the AEC four years ago, is designed to provide advanced training and on-the-job experience for men and women physicians in the field of industrial medicine, particularly in relation to the atomic-energy industry.

The fellowships are open to United States citizens who hold M.D. degrees from approved medical schools and who have had at least one year of internship. In exceptional cases, equivalent experience may be accepted in lieu of the internship requirement. Successful candidates must be investigated by the FBI and approved by the AEC before receiving fellowships.

Awards are for one year's academic training at institutions offering approved graduate courses in industrial medicine which can provide special training facilities in the health problems associated with the atomic-energy program.

Normally, fellows will be eligible for a second, or in-plant, training year upon successful completion of the academic

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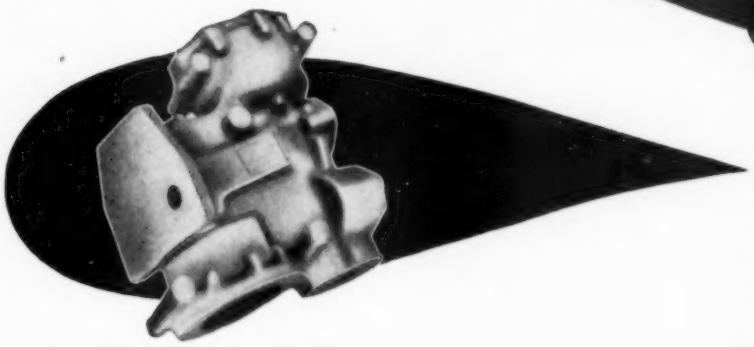

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Atomic Energy

year. In-plant training will be given in medical departments of major AEC plants and laboratories.

There is a critical need for qualified industrial physicians in atomic-energy installations, and at the end of the 2-year training period fellows may find employment in the program. However, there will be no commitment on the part of the AEC to continue the applicant's training beyond the first year or to provide employment for him upon the completion of training. Fellows will not be obligated to take the second year of training or to seek employment with the AEC or its contractors.

TO BUILD NUCLEAR REACTOR

The Atomic Energy Commission has approved the allocation of fissionable material as fuel for a nuclear reactor to be built by Pennsylvania State University.

The low-power "swimming-pool" type reactor will be operated for nuclear research and for the training of students. It is the second privately owned reactor for which the AEC has authorized the use of nuclear fuel. The first, built by the Consolidated University of North Carolina, began operation September 5, 1953.

The Pennsylvania State University reactor will be constructed and housed on the university campus for an estimated $250,000 to $300,000. The cost of construction and operation will be borne by the university, without financial assistance from the AEC. The reactor will operate at a power level of one hundred kilowatts. It will be cooled and moderated with ordinary water and will use enriched uranium fuel. The fuel elements will be suspended in a pool of water sufficiently deep to serve as a shield against the radiation produced by the reactor.

A similar "swimming-pool" facility, the Bulk Shielding Test Reactor, has been in operation at Oak Ridge National Laboratory since 1952. Experience with the Bulk Shielding Test Reactor has demonstrated that this type of reactor is inexpensive to build, safe to operate, and easy to maintain.

Actual transfer of fissionable material required for the reactor will occur after the AEC has given final approval to health, safety, and security aspects of the completed reactor and the plan for its operation.

The reactor project is under the technical direction of Dr. William M. Breazeale, professor of electrical engineering at Pennsylvania State University. Dr. Breazeale was formerly on the staff of the Atomic Energy Commission's National Laboratory at Oak Ridge, Tenn., and was also project engineer for the Bulk Shielding Test Reactor at Oak Ridge.

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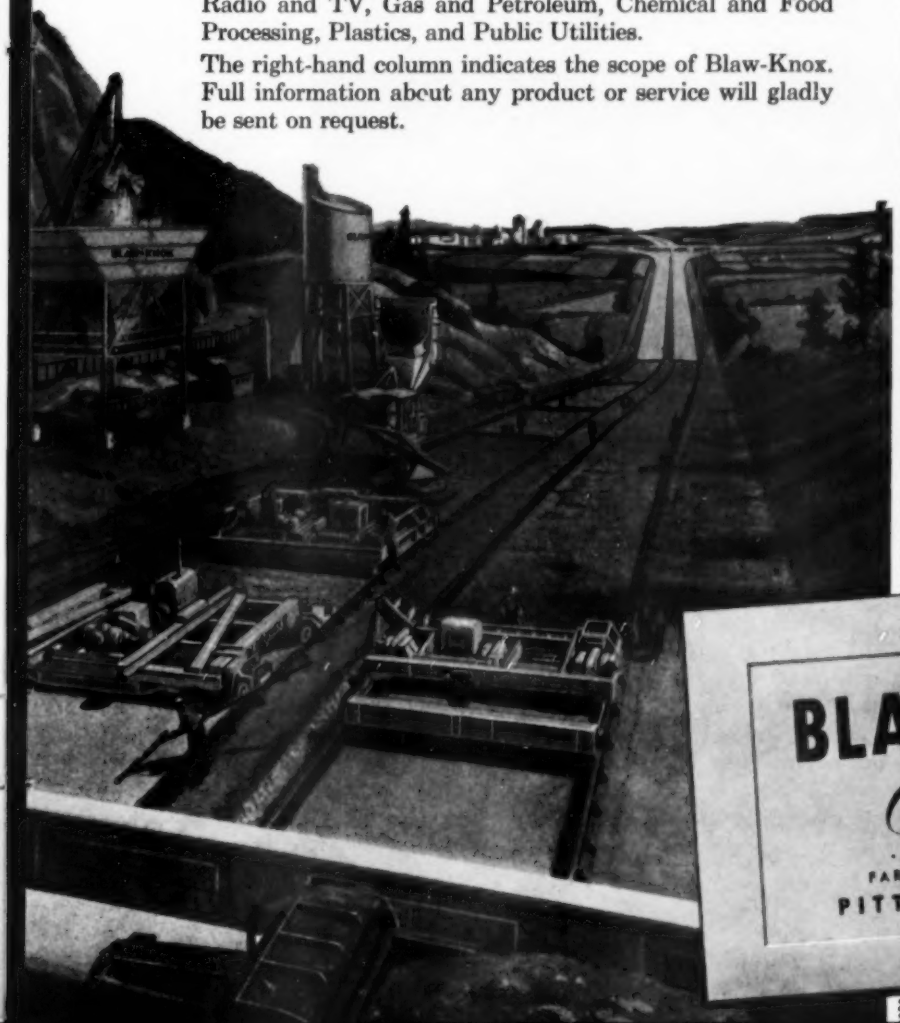

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GEN. NATHAN F. TWINING

Chief of Staff, United States Air Force

Power for Peace

Our ability to retaliate swiftly is a deterrent to aggression

ABRAHAM LINCOLN was once challenged to fight a duel. The challenger demanded that he name the weapon.

The great rail-splitter was a peaceful man, but he was also a tall and powerful man.

"I accept the challenge," he said, "and the weapons will be broadswords."

Needless to say, the duel was never fought.

Peace between the most powerful nations may be kept, and it has been kept, by the same method as Lincoln used.

His superior ability to strike with a deadly weapon served to cool the warlike intentions of his adversary.

The ability of the United States to reply to any blow that an enemy may deliver with a heavier and more decisive blow can be an effective guarantee that the first blow will not be struck.

The Lincoln principle is still valid. President Eisenhower recently said that it was a fundamental truth that our Nation's best defense lay in its capacity for swift, powerful retaliation against an aggressor.

He declared, in a reference to the atom and hydrogen bombs, that the greater the destructiveness of weapons, the greater was the value of a surprise attack. And the deterrent to such an attack, General Eisenhower said, is the knowledge by the potential aggressor of the power for instant, destructive retaliation.

OUR military-naval-air defense structure today has a "new look."

Adm. Arthur W. Radford, Chairman of the Joint Chiefs of Staff, described this new look as "a reassessment of our strategic and logistic capabilities in the light of foreseeable developments, the world situation today . . . and considerable estimating of future trends and developments. It is a searching review of this Nation's military requirements for security.

"The new look prepares for the long pull; not a year of crisis. It is aimed at providing a sturdy military posture which can be maintained over an extended period of uneasy peace, rather than peaking forces at greater costs for a particular period of tension."

Gen. Nathan F. Twining, Chief of Staff of the Air Force, whose photograph appears on the opposite page, was called into Federal service with the Oregon National Guard in 1916 and was graduated from the U. S. Military Academy in 1918.

In 1926, having completed flying training, he transferred to the Air Service. He was graduated from the Air Corps Tactical School and the Command and General Staff School.

Shortly after the attack on Pearl Harbor, General Twining was named Director of War Organization and Movements in the Office of the Chief of Staff of the Army Air Forces.

He went overseas in 1942 as Chief of Staff of Allied Forces in the South Pacific and subsequently was named commanding general of the Thirteenth Air Force in that theater. A year later he was placed in tactical control of U. S. and Allied air forces in the South Pacific area.

Later in 1943 General Twining assumed command of the Fifteenth Air Force in Italy and of the Mediterranean Allied Strategic Air Forces as well. Returning to the Far East in 1945, he commanded the Twentieth Air Force during the final stages of the war against Japan.

General Twining's postwar assignments included duty as Commander, Air Matériel Command; Commander in Chief, Alaskan Command; and Vice Chief of Staff of the Air Force.

He assumed his present duties as Chief of Staff of the Air Force on July 1, 1953.

For the moment the hope that it will be possible to avoid atomic warfare is in the ascendancy. In President Eisenhower's proposal for the beneficent development of atomic energy, in the decision to withdraw two divisions from Korea, in the decision to reduce the military budget in the next fiscal year —in all this there is an optimistic and energizing hope of world peace.

PERHAPS it is apparent to an enemy at long last that an atomic arms race can quickly reach a kind of dead end. When each nation can make a flaming rubble of the other's cities in a matter of hours, the utter futility of resort to war must be manifest even to fanatical ideologists.

Our fledgling optimism, however, has not been accompanied by a popular demand that we dismantle our defenses. While the United States will somewhat reduce the size of its military manpower, this by no means signifies an abandonment of the ramparts of freedom. The greater emphasis on our new galaxy of weapons may well result in a strengthening of our military potential.

We have weapon superiority, and we intend to keep it. Our intentions are peaceful. We have no designs for threatening any other country. We just want to make very sure that, if we are attacked, we will be capable of immediate retaliation.

This is the primary responsibility of General Twining: to keep our air guard up as the surest guarantee that no other nation will be so foolhardy as to attack us.

The Nation is fortunate in having such a capable and experienced officer in command of our mighty, ready-to-go air armada in this critical period.

Alert the Guard!

The rôle of the modern Minuteman must be assumed by the National Guard in manning many antiaircraft artillery posts to protect our cities from complete destruction by unheralded air attack

Maj. George Fielding Eliot

THE wheel has come full circle. Once more, as in the days of our Colonial forebears, the people of our communities must be armed and trained for defense against surprise attack. Once more the shadow of horror lurks just at the edge of the firelight from American hearths.

Now, as then, there are regular forces for the defense of the country as a whole. But they cannot be everywhere. When a situation arises in which individual communities may be suddenly attacked without warning, whether by local savages from the forest or foreign savages flying through the air, then each such community must be prepared for self-defense.

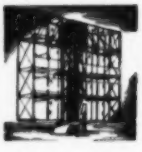
This means that the people who live there, or a sufficient number of them, must give some of their time to the necessary training and must provide themselves (or be provided by the government) with the necessary weapons and equipment.

IN the dawn of our history, urgencies of this sort brought into being the first Colonial militia companies. Those old-time militia outfits have grown into the National Guard, one of the most powerful elements of our defense forces, whose divisions have fought with distinction on the battlefields of Europe, the Pacific, and Korea, and must still be ready to fight wherever called on.

Yet today, in the middle of the twentieth century, the National Guard finds itself called upon, in addition to these heavy responsibilities, to assume once more a share of the burden of local defense: specifically, of the defense of the cities of the United States against hostile air attack.

Major Eliot is military and naval correspondent with General Features Syndicate and military analyst for the Mutual Broadcasting System. He is the author of several books including "The Ramparts We Watch" and "Hate, Hope, and High Explosives." His article, "Has the Army Lost Its Soul?" which appeared in the July-August 1953 issue of ORDNANCE, *was widely acclaimed.*—THE EDITORS.

Once more the citizen-soldier must be ready to run at a moment's notice to his loophole in the stockade—or rather, to the battery site where his radar-directed antiaircraft guns point their long barrels skyward. Once more,



upon his readiness to perform this mission effectively may depend the survival of his home community—and upon knowledge of that readiness may depend the chance of his home community never being attacked at all.

But to be effective, either as defense or deterrent, the readiness must be real: real in terms of efficiency, real in terms of time. In the ordered security of the past century, Americans have almost forgotten what it means to keep citizen-soldiers in a state of *instant* readiness.

Somehow there has always been time to make up for deficiencies in training and equipment after war began, even though that time has all too often been dearly purchased at the price of unnecessary bloodshed. Now it cannot be purchased at any price save that of devastation and defeat any more than our forebears could have purchased it at any price save that of death or captivity.

Now let's get down to cases and see what all this means in terms of the job to be done by the National Guard's antiaircraft units.

THEIR mission is to man the 120-mm. gun batteries which form the inner ring of defense against hostile aircraft seeking to attack any of our larger cities. The outer ring will be composed of Regular antiaircraft batteries armed with Nike guided missiles—and possibly in future with missile weapons of longer range than Nike.

Both types of batteries are part of the Air Defense system, which also includes fighter-interceptor squadrons of the Air Force (some of them Air National Guard squadrons) and the necessary warning and communications network. With regard to the defense of particular localities, the Air Defense

Command has over-all operational responsibility, exercised through appropriate subordinate commands.

The necessity for manning the AA gun batteries with National Guard personnel began to be recognized as long ago as 1951 as the AA guided-missile program began to develop. It quickly became clear (1) that guided-missile batteries could be operated only by regular, full-time, highly trained personnel; and (2) that the numbers required for this purpose would pretty well exhaust the available regular personnel allotted to the Antiaircraft Command.

Therefore the Antiaircraft Command would require very large additional numbers of personnel if it were to man both the guided missile and the gun units. Since, under foreseeable budget policies, this could only be accomplished by undesirably reducing the strength allotted to other components of the Army, the alternative policy of using National Guard units to man the gun batteries was initiated by a memorandum from the Chief of Staff of the Army to G-3 on January 10, 1951.

A SERIES of conferences involving Army Field Forces, G-3, the Antiaircraft Command, and the National Guard Bureau took place during 1951 and 1952. In August 1952, representatives of the two last-named agencies drew up a task force organization which assigned "site missions" to eighty-one National Guard antiaircraft gun battalions.

Following this conference, representatives of the Antiaircraft Command and the NGB conferred in Washington with the State adjutants general and laid the plan before them.

The adjutants general gave their wholehearted support to the program and in many cases relocated antiaircraft artillery units closer to their assigned sites. In some States additional antiaircraft artillery units were organized; in others, automatic-weapons battalions have been converted to gun battalions to meet the desired objective.

Under present plans, the National Guard will eventually provide eighty-one gun battalions and nine automatic-weapons battalions for air-defense purposes in the continental United States. Virtually all these battalions will be recruited from the populations of the areas in which their primary defense mission lies. All are now in existence and federally recognized, but they are very far, as yet, from being ready to take over their new tasks. In fact, only one battalion is so ready right now—the 340th Antiaircraft Battalion (Gun) of the District of Columbia National Guard.

Probably not more than six National Guard battalions will be ready by the end of this fiscal year—June 30, 1954. But during the next two years very considerable progress may be expected.

A slow start? Yes, but it is surely better to go at this problem carefully and methodically than it is to plunge ahead with half-baked ideas amid a blaze of publicity which might too easily give the people of our cities the illusion of protection without the substance.

First of all, the Federal Government must provide the battery sites. Many are now under Army control, manned by Regulars who are going to shift to Nike sites farther out. Next, permanent maintenance personnel (chiefly electronics specialists) must be procured and trained on the basis of fifteen skilled individuals per battery.

These men will be paid from National Guard funds as civilians, at rates varying according to skills and assignments from $3,000 up to $6,000 a year. They will, in addition, be members of the National Guard battery assigned to the site and will thus be under the military control of the battery commander. One will be a commissioned officer. They will be permanently quartered at the site and, besides maintenance, will have security duties.

UNTIL personnel of the necessary qualifications can be made available on this basis, Regular Army personnel will remain at the site to perform these duties.

The Federal Government will also provide a high wire security fence around each site, watchman's clocks, telephone communications, the necessary shelter, and, of course, the weapons and equipment. In most cases the batteries will be armed with the 120-mm. antiaircraft gun, directed by the M33 fire control.

Minimum standards of qualification will be set up by the Chief of Army

Our cities will depend on the barrage for close-in air defense (Signal Corps photo).

Field Forces for each National Guard unit based on qualified personnel to fill a prescribed quota of Military Occupational Specialties. School assignments will be made available within the limits of capacity for the rapid training of such personnel.

Special courses are now under consideration for men already having some degree of electronics experience in civil life so that these need not take the time for a full course out of their civilian careers. To get enough men willing or able to take "time out" for this purpose will be difficult enough anyway.

Training, however, does not have to wait for full attainment of these minimum standards; it is intended that National Guard batteries shall start training "on site" as soon as possible, without assuming any responsibility for the defensive mission until qualified.

As batteries reach the required level of training and efficiency, they will be run through tests under the direction of the Antiaircraft Command. Each battery as it is found qualified becomes a "special security force" and will then be fitted into its place in the air-defense network and will assume a definite mission.

THIS will be a progressive development, with National Guard battalion, group, and brigade headquarters assuming command responsibilities as they, too, reach minimum standards required for that purpose.

The ideal personnel situation will be attained if enough qualified men who were residents of the area immediately adjacent to the battery site could be assigned to each battery to provide the full strength as specified in the Tables of Organization and Equipment. This may not always be possible because of the fact that the battery sites will be located in outlying areas, some of them sparsely populated.

At present the tendency is for National Guard armories to be found in the midst of thickly populated districts —both for recruiting purposes and for convenience so as to secure maximum attendance at drills. To take one example from New York City, the armory of the 212th AAA Group is at 62nd Street and Columbus Avenue, which could hardly be much closer to the center of Manhattan.

If a battalion of this group is assigned to a series of battery sites on the farther outskirts of Queens, the assembly of the personnel at the armory and their transfer by any available means of conveyance to their battery sites is going to be a matter of two or three hours from the time of the alert.

This won't do. Today we have to think in terms of a surprise attack without warning (just like the Indians coming out of the woods). For these National Guard batteries an "alert" system will have to be arranged so that the personnel can dash right from their homes to the battery site if the whistle blows.

Enough people to fire an "operational mission" with the assistance of the permanent personnel should be available by H-hour plus thirty minutes (this isn't official, it's just an approximation).

There won't be time for the personnel to be gathered at any assembly point and proceed to the battery site in a body: they will have to rush right from their homes to the battery site individually. Hence enough of them to operate the battery should live close enough to the battery site so that the time limit can be met.

Consideration must also be given to the fact that in big cities like New York, if an alert takes place during the daytime, even men living near the battery site may be at work as much as an hour's time away. The manner in which the personnel will be notified of an alert also requires study: local fire-alarm arrangements may be used in some cases, or one man (to be alerted by telephone) may be made responsible for notifying others living near him, or individual telephone alerts may be required in some cases. All these problems will vary in different localities.

THE recruiting and training programs for these National Guard antiaircraft artillery batteries will take into account these special conditions. It is one thing to persuade men to join up with an outfit that requires one drill night a week in a nice warm armory: it's quite another when the drill requirement may involve exposure to all sorts of inclement weather at some battery site out in the "sticks."

Practice "alerts"—which may come at highly inconvenient times—will be a necessary element of the training. So a high order of leadership will be demanded of battery, battalion, and higher commanders, upon whom will devolve the responsibility for building up unit spirit to the point where these sacrifices will be accepted.

Taking over this new and heavy burden of responsibility hasn't been made easier by the fact that almost all the battalions concerned have recently been returned to State control after being federalized during the Korean

A battery of long-range 120-mm. antiaircraft guns in action.

War. In most cases only a handful of personnel came back to the States, so that the National Guard had to start rebuilding units almost from scratch.

This, of course, was the result of the transfers of personnel due to rotation and other exigencies, and the practice of "levying" on National Guard units as soon as they become federalized to provide drafts for units in the theater of operations.

By these processes, the original National Guard personnel with State as well as Federal obligations, were soon dissipated to the winds of heaven. Those who were discharged returned to their homes as individuals, the units lost their original character and when demobilized contained almost nobody who had any remaining State obligation to serve in the National Guard.

For example, one New York antiaircraft artillery battalion reverted to State control with a grand total of six enlisted men. Approximately 500 officers and men are required for the minimum organizational strength of an antiaircraft gun battalion.

All States having such units have been making efforts to rebuild them to meet the new responsibilities. In a recent bulletin of the National Guard Bureau, twenty-seven antiaircraft gun battalion commanders were specially commended for intensive recruiting efforts during September and October 1953. Yet even these efforts had produced, on the part of these commended battalions, average strengths of only 250 to 300. Only 2 or 3 battalions had reached 400.

THE majority of the battalions returned from Federal control haven't yet gotten much above 150. On the other hand, those few which were not federalized during Korea are in much better shape, being in many cases close to or even above the required 500-personnel mark.

To aid recruiting, the age limit for original enlistments in antiaircraft gun battalions assigned to air-defense missions has been raised to 45 in order to permit the enlistment of specially qualified men (particularly those with electronic skills); men with prior service may be accepted up to 56.

Here, too, there are complications; some battery commanders feel that these older men will not get on too well with their present personnel, of which the bulk is composed of youngsters enlisting between the ages of 17 and 18½ in order to acquire immunity from Selective Service. Others, however, accept this challenge to leadership and will take it in stride.

THE feeling of responsibility for the defense of homes and dear ones will certainly play a considerable part in keeping up the strength of the Guard's AAA battalions. Nothing quite like this responsibility has hitherto been laid upon National Guard units in modern times, except for State missions in connection with disaster relief.

Thoughtful Guard officers believe that this consideration may well become the cornerstone of the unit spirit which will sustain these battalions through the years.

It is this writer's conviction, however, that in the end some method which does not depend on voluntary enlistments will have to be adopted in order to provide an adequate and dependable source of personnel for these National Guard AAA battalions.

Their mission is too important as a key element of our national security to be left to the chance that the voluntary system—which has proved a broken reed, indeed, throughout the course of our military history—will over a long period of time continue to keep them up to the minimum strength required for the discharge of their duties.

Indeed, these observations apply with equal force to all combat units of the National Guard, since it is clear that the entire Guard must hereafter be maintained in a far higher condition of readiness than ever before. For the long pull, this Nation must depend on the citizen-soldier, the citizen-airman, sailor, and marine. Neither we nor any other people can support enough full-time defenders to meet the needs of war.

The new factor is that of time. The citizen-serviceman will not in future have a year or two in which to get ready after the war has started. The quality of training required and the time necessary to acquire that training are increasing with every new development of the material of war.

Since these highly trained citizen defenders will also be required in future in far greater numbers than in our dear safe past, it is likewise clear from previous experience that we cannot get enough of them by the voluntary method. This harsh fact has long been recognized by National Guard officers, though there is no unanimity of opinion as to how the problem can best be solved.

ONE suggestion, made by Maj. Gen. Lewis Hershey, the Director of Selective Service, seems to this writer to have considerable merit. It is based on establishing draft quotas adequate not only to meet the needs of the Regular forces but also the needs of the National Guard and other active citizen components.

At the end of basic training the draftees would be allowed to volunteer, if they so elected, to serve three years in the National Guard or other active Reserve force instead of completing their 2-year term of Regular service.

Regular monthly quotas for each Reserve component would be established to meet anticipated needs. If the number of volunteers exceeded these quotas selections could be made based on individual qualifications and other pertinent considerations.

Meanwhile, during 1954 the Army's "mobilization assignment" plan, by which individuals having a Reserve obligation are assigned for mobilization purposes to National Guard and Reserve units, is being tested in several States.

It would seem that the urgencies attendant upon the new antiaircraft mission of the National Guard might very well motivate the use of this activity as a sort of laboratory for trying out suggested methods of personnel procurement for citizen forces so that future legislation proposed to the Congress can have behind it a record of practical experience based on fact, rather than mere conjecture.

Outlook for Air Power

The ability of potential enemies to strike us without much warning indicates the need for continuing development of more effective aircraft armed with new types of weapons

Lieut. Gen. L. C. Craigie

THE advances in performance of aëronautical equipment throughout the past fifty years have been phenomenal, particularly during the past fifteen years. The two outstanding events of this period were the advent of the jet engine and the penetration of the supersonic barrier.

During World War II the foresight of our air leaders and planners, coupled with the tremendous capability of our air industry, enabled us to excel in long-range, high-altitude bombers from the very beginning. The B-17's in Europe and the South Pacific and the B-29's in the Far East gave us a margin of superiority beyond challenge.

In fact the B-29's conquest of Japan so impressed the Soviets that they decided to "invent" it themselves. They gave the "invention" such high priority that they were soon able to reproduce it by the hundreds, undoubtedly adding some improvements of their own.

TODAY the Soviets have a fleet of long-range bombers comparable in numbers to our own Strategic Air Command and comparable in performance to most of the planes of that Command. They have atomic and perhaps thermonuclear weapons. We know, of course, that explosions have occurred.

Since this has happened, the importance of air defense has increased tenfold. Unfortunately, the difficulties and limitations of air defense have increased by the same proportion.

General Craigie is Deputy Chief of Staff for Development, United States Air Force. These remarks are based on an address delivered by General Craigie before a meeting of the Washington Post of the American Ordnance Association held at the Press Club, Washington, D. C.

Today it seems that a large segment of public interest is focused exclusively on the "defensive" weapons of air warfare—surface-to-air missiles, piloted interceptors, antiaircraft guns, and early-warning radar. These weapons, however, in the full course of a war are not likely, by themselves, to provide the real answer for stopping air attacks.

Until pilotless interceptors are perfected, the piloted interceptor is very much in the picture. Compared with other type fighters, this plane must be fast and possess an exceptionally high rate of climb. Consequently, it will be limited in range and endurance. Speeds, altitudes, and maneuverability of these aircraft are constantly improving.

Although not an interceptor, the North American F-100 was the first production model of a fighter to exceed the speed of sound in level flight.

Other supersonic fighter aircraft are being built to carry an increasing number of electronic devices to aid the pilot. He, in turn, can carry human intelligence to the target and so is in a position to overcome some of the evasive tactics and evasive maneuvers of the enemy.

Because of the tremendous destructive power of new weapons, very high losses of aircraft would be acceptable to an enemy today if he could reach his target or targets.

HE also knows that the range and speed of his modern bombers have increased our problems of detecting, identifying, intercepting, and destroying them. The commanders of his air force must also be given credit for reasonable intelligence. They can be expected by deceptive feints, by variations of courses and altitudes, and by swift concentrations or dispersions to evade defenses at one point and saturate defenses at another.

Even if we had a fully manned and up-to-strength Air Defense Command the problem would not be licked. In the past, when engaged in a full-scale war we have never been able to have enough in the way of air defense to meet all enemy attacks that were thrown at us. Any hope of having enough of all the various elements of air defense to protect all targets and stop all attacks is wishful thinking.

The dollars required for a fighter and ground-air missile defense that could guarantee us one hundred per cent defense would disrupt our economy. Yet, even if we could bear the

cost financially, it would provide no solution to the problem of how to win a war.

Despite these difficulties, our home air defenses must be and are being improved and strengthened.

We consider that a vital part of our over-all air defense is provided by our ability to "go to bat" with a strong offensive force. Bombers which can extend deep into the enemy's own back yard can paralyze his will to wage war.

We realize that the long-range bomber can be detected and identified somewhat more quickly than a smaller airplane and that some targets are more adaptable to a smaller plane. Yet the small airplane lacks the range to reach these targets.

As one solution to this problem we are converting long-range bombers into air carriers for smaller and faster planes. These planes, capable of carrying an atomic bomb, can be launched hundreds of miles from the target and recovered by the carrier after its mission.

The air-defense concept that I have briefly outlined can perhaps best be summed up as "the best air defense is a good offense."

IN either offense or defense the crux of any weapon system is "firepower." We can continue to produce increased performance in our aircraft and still not hold the winning hand if these aircraft have firepower inferior to that of our potential enemy. This is particularly true of the offensive and defensive fighter-type aircraft. Integration of firepower, radars, computers, airframe, power plant, and all supporting equipment produces a "weapons system."

In an air battle the pilot has four things to do: (1) force the enemy into combat, (2) close to effective range, (3) secure hits, and (4) make sure his hits are lethal.

The ability to secure hits and to have them lethal is the area in which many members of the American Ordnance Association are primarily concerned.

One of the questions facing the Air Force today is: "Has armament development in the aircraft field in this country kept pace with this progress." The answer is "No, not quite."

We have no desire to attempt to fix the blame or responsibility for our shortcomings and deficiencies. The important thing is to correct them. With the hope that it would help the situation the Air Force published a regulation known as Air Force Regulation 136-1 which sets forth policies now in effect governing the Air Force armament program.

I should like to stress that when we refer to armament we include not only basic ordnance such as guns, ammunition, rockets, bombs, etc., but also the fire-control and bombing systems for their utilization. Excerpts from this regulation are as follows:

"Policy: (a) Combat aircraft will be considered as complete weapon systems from conception to the end of service life. This concept requires the integration of armament equipments in future aircraft design proposals. . .

"The development and procurement of all Air Force armament equipment is the responsibility of the Air Force. In consonance with the principle of cross-servicing, other Government agencies and facilities will be utilized to the maximum extent consistent with furthering the objectives of the Air Force armament program. . .

"Responsibilities: (a) The regulation stipulates that the Air Research and Development Command will be responsible for:

"1. Development of all Air Force armament equipments, using other Government facilities and agencies to the maximum extent considered feasible;

"2. Emphasize, encourage, and support the development and participation of United States industry in the research and development of Air Force armament equipments which will insure development capability in times of peace as well as in war;

"3. Provide or secure such facilities as may be required to insure complete and comprehensive development, development testing, and evaluation of armament items prior to quantity production;

"4. Determine modifications for qualitative improvement of armament systems committed to production or in service use;

"5. Require the integration of armament equipments in all combat aircraft design proposals."

WHEN compared with the other services, the relationship between the Air Force and the ordnance industry is unique. We are almost exclusively in the rôle of the customer. The other services are more in the rôle of partners in that they possess internal organizations and facilities for developing ordnance-type items.

This unique rôle, combined with the publication of AFR 136-1, has led to many speculations and rumors as to the future Air Force position in this field. We constantly hear the question: "Is the Air Force going to attempt to attain its own internal ordnance capability?" This is definitely not the intent of the Air Force.

The purpose of the Air Force policy statement was to emphasize the field of armament and the need for keeping it in proper phase with aircraft development. The ordnance departments of the other services will continue to procure the majority of the basic ordnance items for the Air Force.

There is no intention to duplicate either the testing facilities or the buying organizations of either of these services. Their technical skills and know-how and facilities will continue to be utilized to the maximum extent possible. Wherever the Army and Navy can produce on acceptable terms the armament required by the Air Force, that organization will continue to be utilized.

Our goal is to attain an internal management structure possessing the technical know-how required to manage the Air Force armament program properly and to insure a completely integrated weapon system.

I recently talked to Brig. Gen. L. I. Davis, Headquarters, Air Research and Development Command, whom I consider the Air Force's outstanding authority in the field of armament. I told him that I planned to address you and I requested some ideas from him relative to points which he considered appropriate for me to discuss with you.

I received a short memorandum from him outlining some of these points, and I will give the sense from his memorandum with a few interpolations of my own:

1. The trend in improvement of aircraft guns has not kept pace with the aircraft and electronic advances.

a. The ordnance and the ballistic arts are old and well established. People have been building guns and explosives for hundreds of years. It appears that ordnance engineers and designers are working against limits imposed by the strength of materials and the energy available in conventional explosives.

On the other hand, we see rapid advances in aircraft. Turbojet power makes possible supersonic speeds in level flight. We have doubled the speed, altitude, and range of combat aircraft in the past ten years.

IN this same period, physicists and electrical engineers have brought radar and electronic computers to a state of perfection which makes them indispensable in military operations.

b. In comparing progress in ordnance with progress in other fields of engineering, we have to admit that there has been *some* improvement. The caliber .50 gun used in Korea has a rate of fire fifty per cent greater than the gun used in World War II. New mechanisms which make possible higher rates of fire for larger calibers give promise of efficiencies perhaps one hundred per cent greater than the World War II weapons.

But this is not enough. To match the progress in other fields, scientists and other engineers working on ordnance problems must bring forth more basic and fundamental improvements. Ingenious mechanisms and five and ten per cent improvements in metals and explosives are not sufficient to keep up with the pace of modern weapons systems.

This may be a strong indictment of the gun designers, but one has only to look at our modern interceptors to see that guns have been superseded by rockets and that guided missiles are just around the corner.

c. Supersonic bombers raise the question of the advisability of carrying conventional defensive guns as employed in World War II. Rockets and napalm are challenging the rôle of guns in ground attack, and the tactical A-bomb has moved to top priority on the list of tactical support weapons.

If the gun is to keep up in this race, advances greater than five and ten per cent must be made. The Air Force stands ready to talk over its air ordnance problems with industry. We can state the military problems peculiar to air employment of air ordnance, but we expect you to contribute the scientific or engineering break-through necessary to achieve a really significant increase in weapons effectiveness.

2. Rockets have replaced guns because guns have not kept up—but rockets are not all they might be either.

a. The potential effectiveness of rockets is seriously compromised by poor dispersion, especially at altitude.

b. The effect of temperatures on burning rate, and therefore on time of flight to target, is seriously compromising the use of rockets.

c. The compatibility of launching tubes with fin design and initial pressure has given considerable trouble.

d. Large-scale production of aircraft rockets has lagged, due to either poor initial design or poor quality control by production sources. Until recently, this was a very serious problem to the Air Force.

The end effect of these deficiencies: If aircraft rocket design and production problems are not solved, we will be forced to depend heavily on *air-to-air guided missiles*. These are exceedingly expensive and complicated. Their use for a large proportion of military missions, including training, might be prohibitive.

> *"In either offense or defense the crux of any weapon system is 'firepower.' We can continue to produce increased performance in our aircraft and still not hold the winning hand if these have firepower inferior to that of our potential enemy."*

On the other hand, satisfactory solution to present rocket problems would result in air ordnance being markedly improved compared with present guns and much less expensive than the guided rockets.

3. Our research and development problem in aircraft guns and in aircraft rockets is under continuous review by successive committees. The effort to prevent undesirable duplication is laudable, but these reviews have operated to inhibit the development of new air-ordnance items.

a. The number of active gun and rocket design projects in our present program is not excessive in comparison with the number of airplane and engine designs. These are necessary to keep pace with modern weapon technology. Military needs require continuance of efficient small-caliber weapons for tactical targets.

b. In the majority of air-ordnance developments, the Air Force is the customer and transfers funds to Army Ordnance and the Navy Bureau of Ordnance for research and development.

We would like to deal in a competitive market. Overzealous ad hoc committee action to "prevent duplication" has approached a degree where competition has been stifled and, in some cases, "insurance" or "back-up" programs have been recommended for elimination before the winner of the competition is apparent.

We can't judge all the factors on paper studies alone. Experimental models have to be carried to environmental and flight-test stages in order to choose wisely the best design for production.

GENERAL Davis has something in his complaint. I think it is up to us here in Washington to do something about it.

I have touched on several areas of mutual interest and concern. In the past we have made our best progress when we in the military services and you in industry have approached our problems as a team and have worked toward their solution as a team. I hope we can continue to work together in that fashion.

The Light Rifle

An analysis of some of the merits and shortcomings of the U.S. T-44 and the Belgian FN fully automatic shoulder weapons

A QUANTITY of new light rifles, reportedly about 3,000, is being ordered from the national arms factory of Belgium (Fabrique Nationale de Belgique) for field testing by American troops. This rifle is a new Belgian development, designated FN, that has been tested in small lots in this country in comparison with the U.S. T-44 and the M1 (Garand) light rifle. The T-44 was described in general terms in the March-April 1952 issue of ORDNANCE.

The quest for a new rifle has arisen from the efforts of the NATO countries to standardize on weapons, and of the United States to develop a lighter rifle. Standardization of *all* weapons was first undertaken and soon shown to be hopeless. The NATO planners then approached individual items, first tackling small-arms ammunition. In that field, after several years, five of the leading NATO nations have agreed to adopt and undertake production on a caliber .30 cartridge.

The cartridge selected for standardization is the T-65 developed by Army Ordnance and described in the March-April 1952 issue of ORDNANCE. Compared with the present caliber .30 M2 cartridge it is about a half inch shorter and 10 per cent lighter yet is loaded with about the same weight of bullet and charge to produce the same muzzle energy (2,839 foot-pounds with an armor-piercing bullet).

The T-65 cartridge is made up in all standard types—ball, armor-piercing, incendiary, marker, and tracer—with muzzle-velocity variations from 2,530 to 2,870 feet a second. The T-65 cartridge fits the T-44 light rifle and the FN. Existing rifles, such as the M1 and those of other NATO countries, would have to be rechambered.

With the adoption of a standard cartridge the goal of the NATO members to reduce logistic headaches has been partially achieved. Their next aim is to decide on a rifle that will be acceptable to all. Here the choice has been narrowed down to two rifles—the U.S. T-44 and the Belgian FN.

However, in this country those who worked for years to perfect the Garand M1 have to be convinced that a new rifle offers sufficient advantages to more than offset the tremendous problems involved in changing over from the M1. A physical comparison of the three rifles is shown in the accompanying table.

In attempting to analyze the accompanying table it is seen that there is a weight advantage in the light rifles over the M1. However this is reduced if the weight of a spare magazine is included. What actual over-all weight saving would accrue for the individual or the supply unit depends upon how much increase in units of fire per man per day is allowed in view of the increased magazine capacity and cyclic rate.

	T-44	FN	M1
Caliber	.30	.30	.30
Length	41.5 in.	41.5 in.	43.6 in.
Weight (including empty magazine)	8.2 lbs.	8.68 lbs.	9.56 lbs.
Weight with accessories (excluding spare magazine)	9.14 lbs.	9.51 lbs.	10.99 lbs.
Weight of magazine	½-lb.	½-lb.	(none)
Magazine capacity	10 or 20 rds.	20 rds.	(8 rds.)
Muzzle velocity	All three are comparable, but heavier M1 will withstand higher pressures.		
Relative ease of field maintenance	3	1	2

Comparative statistics for the T-44, FN, and the M1 rifles.

INFORMATION on comparative firing tests indicates that the FN and T-44 show little difference in accuracy, ease of reloading and sighting, or frequency of stoppages. However there seem to be certain factors that require further exploration in comparing the T-44 with the FN or either rifle with the M1.

It is understood that the FN's tested to date are not production-line models, an important consideration for a weapon that must be mass produced. It is assumed that both rifles will be examined critically by our industrial rifle makers to compare them for ease of production since the biggest production load in an emergency would undoubtedly fall on the United States.

An expected advantage of adopting a fully automatic light rifle for our infantry is to replace the M1, BAR, light machine gun, and carbine, perhaps even the pistol, with one weapon.

There is no doubt that the United States has grown strong by being alert to incorporate improvements in its armaments and its industry.

However, when a new weapon is proposed that requires a tremendous retooling operation it seems apparent that it should not replace a war-tested weapon without exhaustive examination, especially by American industry.

Atoms and Red Armies

Russia's military leaders have reorganized the Soviet forces into smaller, well-trained, and predominantly mechanized units to meet the demands of mobile atomic-age warfare

Garrett Underhill

WHILE America has been talking about adapting armies to atomic warfare, Russia has been acting. As a result, Russia's new streamlined armies are well fitted for atomic war while America's armies have come to rate as old-fashioned and very vulnerable.

This may appear incredible, since America's "new look" defense policy is to cut the size of the U.S. Army by relying heavily on atoms to offset the Russians' reputed superiority in mass manpower armies.

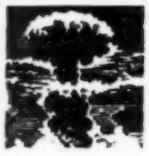
However there is nothing novel about today's situation. It's merely another dreadful instance of America's chronic inability to be "intelligence-minded." We just can't seem to grasp that the other fellow hears what we say and sees what we try out, and often can put into general use new ideas—his own as well as ours—sooner and better than peace-loving, economy-minded America.

THE present situation is actually just the same as that which made possible Pearl Harbor, when Japanese naval experts combined American developments (the airplane and the aircraft carrier fitted with "secret" arresting gear) and went all-out for air-age carrier warfare—while the U.S. Navy talked about aviation but clung to battleships.

Perhaps as incredible as the relative preparedness of Russian and U.S. armies for atomic war is the fact that the Russians have made no secret of their atomic-age army reforms. Just as Guderian ("Father of Panzers") spelled out by 1937 his mobile-warfare ideas in the public press, and the German Army described the Guderian organization, tactics, and weapons it had adopted in the November 1938 *Die Wehrmacht* (a militarized *Life* magazine), *so have the Soviet Army and its thinkers made publicly plain their ideas and their reforms.*

Mr. Underhill served with Army Intelligence during the Second World War and was recalled during the Korean emergency. He is a recognized authority on Soviet arms.

Marshal Paul Rotmistrov, long Russia's ace mobile-warfare thinker, spelled out in 1946 in *Military Thought* magazine the ideas which the Reds put into effect the next year in their new "mechanized armies."



The same year General Gerasimov briefed Russian junior officers and men in the official *Military Herald* to explain the new training objectives and especially the "why" of the unprecedented rigor of atomic-age discipline and training.

Since this Russian thinking is vital to an understanding of Russia's reform actions, let's read what Gerasimov wrote—writings which the U.S. got for the price of its subscription to this pulp-paper fortnightly:

"THE present epoch is characterized by increasing means of destruction. . . .

"The concentration of large masses of men and matériel is unlikely because of the danger of their disclosure and destruction. The concentration of large masses of human forces in limited areas is becoming increasingly dangerous.

"The use of sizable forces is possible only under conditions of swift assembly and commitment... The character of battles will be exclusively one of maneuver."

Gerasimov wrote of future land war depending on the "quick, decisive action of coöperating groups of dispersed small units," and went on to tell the Soviet Army:

"Actions over a wide area, rapid actions in which the junior officer is completely independent and guides his unit in battle with open flanks, is to be the basis of training."

Gerasimov warned that, in order to fit soldiers to fast, independent, continuous action, "physical training of forces must take on a greater importance than now."

The Russian general noted important scientific developments like infrared night-vision devices, and stressed radar detection of ordinary-type hidden artillery. He spoke of radioactivity and

guided missiles and remote-controlled weapons of all sorts.

Let's see what the Russians have done to put their ideas into effect and how American and Russian atomic-age armies stack up according to authorities in both nations.

The most important Red reform is just what has been called for by American Colonels Reinhardt and Kintner in their new book "Atomic Weapons in Land Combat." These experts recommend streamlined new-type divisions of half a dozen brigades, each self-sufficient.

The Soviet Army's "tank" and "mechanized" divisions, created in 1947-1949, fill the bill.

The tank division relies mainly on three "tank regiments," which actually are brigades or "pocket divisions." Each regiment has three companies of 85-mm.-gun T-34 tanks (twenty-one per company), an assault artillery battalion of 152-mm. gun-howitzers (which double either as medium artillery or as heavy-gun tanks), an "automat battalion" of infantry armed with machine carbines and riding in armored carriers, a flak outfit, and scouting and supply detachments.

For heavy slugging the division has a similarly organized heavy-tank regiment, featuring as its main armament 122-mm.-gun Stalin tanks, and the 100-mm. assault-artillery type tanks which are the Russians' prime antitank weapons. A fifth "brigade" is an infantry regiment riding in armored carriers and backed by tank-type vehicles.

THE mechanized division has a tank regiment, a heavy-tank regiment, and three mechanized infantry regiments, each of which has a goodly supply of T-34's besides their infantry-support armor.

These new-type divisions run to a strength of only around 10,000 men—a figure inclusive not only of their 5 "brigades" but also of a big divisional pool of conventional artillery, antiaircraft, rocket launchers, and engineer and service battalions.

In contrast, the present United States infantry division is a huge 18,000-man affair based on only three "regimental combat teams" (a German 1917 idea adopted by America in 1939). Each "RCT" depends upon a manpower mass of a 3,600-man infantry regiment of three battalions, backed by an artillery battalion of only twelve light 105-mm. truck-towed howitzers, and a single company of twenty-two 90-mm.-gun Patton tanks.

The U.S. division has medium 155-mm. howitzers, but they are usually truck-towed and there is only one battalion of them. The division also has a pool of sixty-nine tanks, but these are in a battalion lacking support and service troops to enable it to move and fight on its own.

All in all, the U.S. Infantry division is anything but what atomic-warfare experts want.

Four out of five of America's NATO divisions are of this unwieldy infantry type, while eighteen out of the twenty Russian divisions in East Germany are tank or mechanized. While 17 out of the U.S. Army's total of 20 divisions are old-type infantry, Russia has managed to convert (official reports say) 65 of her 175 divisions to be tank or mechanized.

Russia eight years ago introduced a streamlined form even for her unconverted infantry divisions, slashing them down to around 11,000 men and backing each with a tank regiment including 100-mm.-gun tank-type assault artillery able to outgun 90-mm.-gun Pattons.

U.S. infantry divisions use trucks to carry their men and equipment and tow their artillery. These trucks offer no protection whatever from atomic weapons—or from air strafing and the searing terror of napalm bombs, for that matter.

If the troops happen to be dug in and are themselves thus secure, their trucks nevertheless can be reduced to charred wreckage and the division thereby robbed of its capacity for major maneuver. If the troops try to move or fight on foot, then they have only "shirtsleeve protection" against the 3-ply effects of an atomic bomb: heat flash, radiation, and blast.

IN contrast, the Russian divisions stress tanks and tanklike assault artillery, with crews covered over by armor. While the U.S. infantry division has only 144 tanks, Russia's "new look" mechanized division has over 270 tank-type vehicles and the tank division nearly 350.

Russia's reason for this reform is obvious. America's expert Colonel Reinhardt has written that "tank crews behind their armor are the most protected soldiers on the battlefields." He tells us that steel armor is invaluable in atomic war because "any thickness cuts off the menace of flash heat," and "each inch and a half of steel reduces by one-half the degree of radiation which penetrates it."

Robert T. Keller, Chrysler Corporation vice-president in charge of tank production, recently pointed out that tanks can withstand the blast effect of atomic explosions better than any other weapons system. Moreover their armor enables them to move through areas contaminated by radioactivity as no other troops can.

Since U.S. infantry divisions have

The T-34 tank with 85-mm. gun is one of the principal Soviet combat vehicles.

tanks, too, Russian reforms are likely to be misunderstood unless it's explained what Russian tanks are for.

The U.S. infantry division tanks are used as protected, mechanized support guns which are tied in combat to the two-mile-an-hour pace of foot infantry.

The Russians' T-34 tanks are intended to unite the basic weapons of the conventional infantry-artillery team (the machine gun and the light artillery cannon) in a single armored, motorized, cross-country mount; it's supposed to capitalize on its mechanized mobility and move as rapidly as the terrain permits.

Similarly, Russian assault artillery is medium artillery in tanklike form so that it can move right across the battlefield to maintain support of the T-34's. In contrast, U.S. medium artillery, being truck-towed like the light, has to hide far distant from the clash of combat. Even self-propelled U.S. artillery must seek protection, since its carriages are open-topped.

The Russians, like U.S. armored warfare experts, do use infantry with their mechanized machine gun-artillery combinations called tanks, but the infantry act more as "tank marines" who (along with support troops) ride a great deal of the time in armored personnel carriers perhaps better termed "man-carrying tanks."

Lieut. Gen. Bruce Clark, who commanded the I Corps in Korea, has asserted that even the light armor of the new carriers to be used in America's two tank divisions protects occupants "measurably from the blast and other effects" of atomic bombs.

GENERAL Clark hasn't exaggerated, as Maj. Gen. Arthur S. Trudeau showed when he used these carriers to rescue men of his 7th Division, cut off on Porkchop Hill in Korea by a torrent of Chinese artillery and mortar fire. This feat led Maj. Gen. E. L. Cummings, now Chief of Army Ordnance, to name the U.S. carrier the "Lifesaver."

(The Russian carriers appearing in 1951 were only armored trucks with open tops, but it is wise to recall that the Germans in the 1930's built cheap little tanks for maneuver training economy. The Russians have also revealed a big tanklike tractor easily convertible to a "man-carrying tank.")

The views of U.S. authorities quoted are backed by the U.S. Armored School, which has found that a tank division can be hit by an atomic bomb and yet attack successfully—while under similar conditions an infantry division would be wrecked.

It's also worth knowing that Lieut. Col. Robert Rigg, a brilliant young officer who was G-2 of the Pacific Ocean "Greenhouse" atomic tests, remains an enthusiastic tanker, while Maj. George Patton, II, is sure he was right to shift from infantry to armor. United States atomic-warfare authorities, as well as Russian, tell us that a commander "must keep his forces dispersed to such an extent that they do not offer suitable targets for atomic weapons"; yet to attack he must be able to regroup and strike swiftly.

THE ways in which Russia's "tankization" facilitate such suppleness are summed up by Col. Rothwell H. Brown in advocating similar forces for America: "The ability of armor to disperse, without loss of control and military effectiveness, is so much greater than that of the standard infantry division as to need no elaboration."

All the layman need know is that tanks are fast cross-country vehicles fitted with powerful radio, while the infantry in combat consists of scattered groups of footmen with a radio to roughly every fifty men.

It should be obvious why American authorities claim it's vitally necessary to rely on radio in atomic-age war—and why Russia's streamlined divisions are equipped and trained to work by radio. Of America's communications fitness Brig. Gen. R. W. Porter, Jr., has recently said:

"I believe that the U.S. infantry divisions do not place primary reliance upon radio for communications. At present they do not possess the equipment or follow the tactical doctrine which will permit this."

Russia's supply parsimony is now world-famous. In contrast, Colonels Reinhardt and Kintner castigate "the Allied, particularly American, habit of overstocking supplies all the way from front-line battalions to base ports." General Porter joins those who demand U.S. supply practice reform and asserts: "Austerity must govern or disaster will follow, and this applies to rear areas as well as to the tactical battlefield."

ACTUALLY Russia entered the atomic age with a great advantage over America, since she has used the German "bulk-allotment" supply system instead of the American system of "automatic supply."

The relative merits of these systems aren't easy to explain, but what is plain is the supply advantage accruing to Russia from the use of Diesel engines in her tanks and assault gun carriages. America's civil railways, trucks, and buses use Diesel engines for their great economy, and the U.S. Armored Force experiments in 1941 indicated that Diesel tanks saved 50 per cent in fuel. But what surprised experts was that this saving resulted in cutting supply-echelon matériel and manpower requirements by a similar percentage.

Comparison of U.S. gasoline- and Russian Diesel-engined tanks of similar weight and horsepower indicates that savings of two-thirds are possible if the U.S. Army Dieselizes like the Russian —which would be a truly revolutionary economy in supplies and support services, able to enhance vastly the mobility and range of our armies.

U.S. atomic-warfare authorities stress the obvious fact that "accurate, timely information of the enemy can scarcely be overrated," yet U.S. intelligence and scouting is chronically as weak as the Russian is strong.

Just as U.S. forces were completely surprised when two German Panzer armies rose out of the Ardennes to break through at the Bulge in 1944, so the Fifth Air Force and the U.S. Eighth Army in Korea failed to detect the movement across the UN front of the Chinese armies, which later brought disaster to American arms at the Battle of the River.

In contrast, the Germans found that even in World War II sixty per cent of Russian front-to-rear radio traffic *came from behind German front positions,* Russian ability to reconnoiter in force as well as snoop has often been shown, and her big "recon" forces in East Germany alone make America's three "recon" regiments in Europe look pitifully inadequate.

Just as Gerasimov said they would, the Russians have carried on training since 1947 at a tempo unprecedented for peacetime. In America, the horror once voiced at the softness of troops "trained" in the pre-Korean economy era is forgotten, and the country is in the throes of another blind fit of saving which may endanger the national security and the kids who must serve. Suffice it to say that "economy" is as much an operative word in United States defense, as "service" is in Russia's.

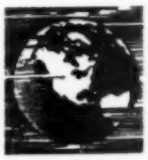
THE ability of armies to cruise over land, overcoming difficult terrain as seaworthy ships do rough seas, the Russians rate as vital. Forces must be "terrainworthy" if they are to carry out dispersion and regroupment—if they are to avoid being held up or canalized in their advance by features forming obstacles to ordinary-type vehicles. Rotmistrov writes:

"Before the war some observers believed that terrain exercised an extremely limiting influence on the use of tanks. We now know that as a result of their technical development (Russian) tanks proved that they can be used in all theaters under the most varying conditions. . . ."

The Russians got terribly terrain-conscious even before World War II. Lacking the surfaced roads of America and West Europe, they originated tanks with broad tracks and powerful engines—characteristics affording low ground pressures and high power-weight ratios. As a result, even Russian tanks of 1937-1939 design put U.S. tanks of post-Korean design in the "terrainworthiness" shade.

Of course quite impossible from the Rotmistrov viewpoint are the U.S. infantry divisions, whose trucks are road-bound. German, British, and indeed all mobile-war experts warn that lack of tracked transport is a frightful U.S. defect. Divisions can't motor-march except on roads, on which they make columnar targets easy for enemy aircraft to find and strafe.

As for U.S. atomic artillery, its high



ground pressure restricts its maneuver capability to a degree which very likely will doom it to the fate of France's underpowered 70-ton tanks of 1940—to be captured or destroyed without firing a shot.

This terrainworthiness matter shows that the fitness of America's armies for atomic war is basically handicapped by the sort of technological ignorance which led many U.S. World War II leaders falsely to suppose that just because a tank was "heavy" it couldn't get around.

Worse yet, U.S. authorities have made the same error which Gen. George C. Marshall said our post-World War I leaders made: they have made plans without studying the last war and without wiping out the erroneous contemporary impressions in the light of postwar historical research.

The effect this has had on U.S. forces' suitability to atomic warfare can readily be made apparent. Gen. Omar N. Bradley, till recently Chairman of the Joint Chiefs of Staff, said of NATO strategy in 1950:

"If we have enough ground troops to make any invader of Western Europe concentrate at natural defense barriers and make him channel his attack along the natural routes of march, the atomic bomb will make a formidable defensive weapon."

THE general and his followers have failed to take into account the way in which the German 1940 blitz drove two Panzer corps of tanks right through Allied troops manning the hilly "impassable" Ardennes Forest, drove across the Meuse River and its gorge, and right through General Corap's Ninth French Army covering the river barrier and the Maginot Line extension.

This the Panzers did in three days—without once "massing" or "concentrating." Within a week they were at the Channel, thereby cutting off from their bases the sluggish Allied infantry masses and forcing them to surrender without a major battle.

In the 1940 blitz the Allies had 135 divisions—but only five of the Panzer type, for though they had far more and better tanks than the Germans, they parceled them out to the infantry the way America does today.

The Germans put all their 2,200 tanks in 10 Panzer divisions, which had the war won before the Germans' 100 infantry divisions could make their power felt.

TODAY not ten but eighteen Panzer-type divisions are poised in Germany—Red Russian divisions with tanks far more numerous, powerful, and terrainworthy than the Germans had.

Opposed are only twenty-five active NATO divisions (five Panzer-type), supposed to be able to "cover" the mobilization of reserves to bring another twenty-five divisions to fighting strength. This mobilization must take place under Red air forces with vastly greater numerical superiority over the Allies than the Luftwaffe had.

How—in the light of history and official intelligence of today—can the Bradley school of strategy possibly hope to do what the 1940 Allies could not? How can it hope to make the Reds concentrate?

Unfortunately the Russians know all about this 1940 business, for they started a very vigorous military history effort in 1942, and, more important, they have made its output compulsory reading for all officer ranks.

Only after loss of trained leaders in 1941 did the Red Russians reluctantly employ bludgeon instead of rapier tactics against the Germans. They have always been hot for air power and mechanized land mobility, even when it was technologically beyond their reach. As Rotmistrov put it in 1946, the Red Russians' motto is: "Firepower, not bayonets!"

EDITOR'S NOTE.—The opinions expressed in this article are those of the author and not necessarily those of the American Ordnance Association.

Field Ordnance Service

The best matériel in the world, without the right maintenance in the combat zone, becomes an ineffective and extravagant waste, nullifying the effects of good design and manufacture

Brig. Gen. R. W. Daniels

RELIABLE industrial establishments all know full well the value of sound maintenance for their products and they take steps accordingly to make such maintenance available to their customers.

It is our industry's realization of the necessity for this maintenance that has no doubt put so many American-made items into the commercially advantageous positions which they hold today in domestic and world markets. When customers have confidence that there will be a follow-up, business is bound to be good.

The armed services have known for a long time how vital is the rôle of this important maintenance function, and particularly those of us in logistic circles who have applied ourselves assiduously to its problems for many years.

WITH the advance of matériel in scientific complexity, the maintenance problems advance correspondingly, or perhaps more than just correspondingly, and the need for their proper solutions is greater than ever. In commercial industry this is a matter of dollars and profits; in the armed services it is a matter of lives and victory as well as of dollars.

By the term "field Ordnance service" I am referring to the activity involved in those problems which arise and *must be solved* in the zone of an army in combat, particularly that zone which we call the combat zone. This discussion, therefore, is not to be compared with the operation of "Ordnance Field Service" in its entirety, which includes within its scope the widespread assembly of field-service depots here at home.

In this discussion, besides covering problems of ordnance matériel, I also wish to bring important emphasis to bear on the vital triumvirate—equipment, training, and leadership—which was so forcefully pointed out to us recently by the Army Chief of Staff.

He, of course, refers this triumvirate to the Army as a whole—all branches, services, corps. It is my thesis to bring out that ordnance, as we know the word in its widest sense, must not be confined to the subject of equipment, as many individuals doubtless consider it, but that it requires this same complete triumvirate if it is to insure its functions and carry out its rôle.

Since one of the indispensable aids in gaining this emphasis is good organization, I wish to show what has been done about this aid, with a little of its background.

By the summer of 1941, in anticipation of the war into which it seemed inevitable that we would be drawn, a good deal had been done in the preparing of our combat forces; and of course the lend-lease which President Roosevelt had instigated had done much to get industry's wheels going in the production of matériel.

But the organization of Ordnance troops for use with the field army was still remarkably incomplete, and the conception of its operation was not too profound for the job that lay ahead of it.

FURTHERMORE, in August 1942, when Army Ordnance took over the added responsibility for vehicle supply, it was especially necessary to create new and sounder methods to cover this vitally important activity and to add some appropriate units.

The best matériel in the world, without the right maintenance, becomes an ineffective and extravagant waste. Combat effectiveness is lessened, and the untold energy which has gone into design and manufacture rapidly becomes nullified.

While as in most activities a high standard of men, well educated and trained, can offset imperfections in organization to a remarkable extent, nevertheless this thing we call organization, if it has followed sound and carefully constructed principles, helps amazingly. It especially makes for economy, enabling fewer men to do the job; and an army needs economy like noth-

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ing else, paradoxical as that might sound to some people in this day and age of billion-dollar defense budgets.

At the beginning of World War II the ordnance maintenance service was performed by a battalion *in each corps,* assigned as an integral part of the corps. The battalion was of a fixed standard size. Now we all know how flexible in size and composition our various corps may be, depending on their mission, so that this battalion seldom actually fitted the job at hand. Most of the time it was either too large or too small.

Furthermore, a corps is essentially a tactical unit and should not be bogged down by administrative responsibilities such as ordnance service.

IF a corps commander can effect a break-through in combat, nothing should interfere with his continuing such break-through except enemy action. Duties of a logistic nature must by all means be the responsibility of some one else.

And so, at least in the combat zone, this responsibility properly falls essentially *on the army commander,* and therefore on the army commander's Ordnance officer.

As a consequence, this principle was followed in 1942 in drawing up the new organization. The Commanding General of the Ground Forces, General McNair, was much in favor of this change in principle and backed up its approval. The principle in brief was simply that Ordnance service for the field army belonged under control of the army Ordnance officer.

As is the case with so many principles, there had to be an exception, and in this the exception was important. It allowed (or prescribed) the division, which is another administrative unit, to have an important share in this ordnance service, so the division Ordnance company was improved and allowed to remain as such.

This company, however, was intended to do the maintenance only on those items which could be handled fairly promptly. The echelons and companies belonging to the army were always there to take over the heavier and surplus work. When the division had to move, they might often take over the entire duty of shop maintenance for a necessary length of time.

In the beginning, there was indeed a problem of deciding what different kinds of companies would be necessary in view of the variety of types of combat units and their equipment. There was also the problem of the units which had formerly belonged to the Quartermaster Corps for truck maintenance—whether to revamp them entirely or use them as they were.

They had been well trained and equipped and it seemed smart to use them without much change except to add a small-arms maintenance section. There would be many places where truck units, engineer units, signal units, etc., would be congregated, where trucks and small arms would be their only ordnance equipment.

Later the Persian Gulf Command proved to be one of the largest of these, and there were many others. Likewise within the army area itself there are always spots where units of this type are congregated which do not need the old type of Ordnance company ready for work on tanks and guns as well as other equipment. This would be a lack of economy.

And so the Quartermaster companies were taken over intact and made into automotive-maintenance companies, heavy type and medium, known ever since as the HAM and MAM companies. Other types of Ordnance companies were improved, and some new types were born.

One of these pertained to the antiaircraft matériel. The AA program was immense as planned in the early part of World War II, although it was drastically curtailed a little later. But even so it remained large enough to present a maintenance problem of such size as to deserve special attention and a special type of Ordnance unit.

No such company had existed before —such maintenance as was required being performed by small detachments of specialists in the field or by the arsenal shops themselves within the continental limits of the U. S.

Thus the Ordnance Maintenance Company, Antiaircraft, was drawn up by the Army Ground Forces and approved by the War Department. Its equipment was highly specialized and its personnel specially trained.

In its early stages there were problems, peculiar to any new kind of unit, but these troubles were ironed out with remarkable rapidity, and the AA Ordnance Companies soon acquired a reputation for being among the best of any maintenance companies in the war.

They were valuable for assignment to areas where the AA artillery was massed around certain cities and other important points, and thus the principle of economy was again served.

In the active theaters they were assigned to appropriate battalion headquarters as necessary, essentially for AA work, although they had some amount of capability to do other maintenance jobs as well, as indeed any good Ordnance unit has (or should have).

And this brings us to a discussion of the battalions and regimental (or group) headquarters which have now been standard for Ordnance units for some ten years. Work done previous to 1941 had resulted in the approval and establishment of an Ordnance Battalion Headquarters largely through the initiation of Maj. Gen. Russell L. Maxwell.

IT was used primarily to command the corps Ordnance maintenance companies referred to above and also to provide a control for depot and ammunition companies. It was a most necessary little unit, and with a few changes was reëstablished for use on a much wider scale.

The drawing up of the regiment (or group) headquarters was a simple matter, but getting its approval from the War Department was something else. Certain higher echelons of authority claimed that since no requests from the overseas theater had been received for any such type of unit it was clear that such a unit was unnecessary.

On the other hand, various field and headquarters were a little shy in requesting a type of unit which had not been approved and included in the available lists. This sort of circle was

understandable under the conditions that prevailed during the early part of the war when the principle of economy had practically the same priority in our forces as the principle of combat effectiveness itself.

Since I was so convinced, however, that this type of headquarters was strongly in the interest of economy, and would pay its freight many times over, I finally succeeded in gaining all necessary and complete approvals.

THUS while the operations of our forces in North Africa did not benefit by the new full organization in the flesh, nor did the early part of the operations in the Southwest Pacific reap any benefit, enough time passed so that well-trained and completely organized Ordnance units were with our forces that invaded Europe in 1944 and with most of our forces in the Pacific areas by that same time.

In the Korean War the same essential organization was found to be quite satisfactory. A few changes have been made with the gaining of a few improvements. The most important improvement has probably been accomplished in the function of supply where the so-called Project 170, initiated by the Ordnance School, was introduced.

This very commendable project tends to make the enormous problem of keeping track of hundreds of thousands of spare parts simpler and quicker. It needs some careful improvement, and it by no means takes the place of the smart, able personnel who are charged with the responsibility of maintenance and supply. It is, however, a fine step in the direction of economic effectiveness.

The importance of having smart and able personnel to perform the supply function can scarcely be overemphasized, both as to officers and enlisted men. There is no doubt that in past years the best educated and intrinsically or potentially ablest were inclined to be assigned to design and manufacture. For a man trained in a scientific background there is a special attraction for this kind of work.

An education in mathematics, mechanics, chemistry, electricity, optics, or dynamics has a tremendously varied application of absorbing interest in the field of Ordnance, and problems galore are arising more and more, not only in connection with the expansion of the new things like guided missiles, rockets, and super antiaircraft weapons, but with astonishing improvements in the more conventional items of ordnance as well.

But the supply functions also need more and more a scientific background and experience in the personnel involved. This background should contain the type of mathematics that covers a thorough study of sampling, the theory of probabilities, and the method of least squares, with emphasis on all possible instances of this application. A knowledge of materials and how to shape them is also necessary in view of how much work is done in the field involving this activity.

Above all, supply people should learn how to become "quantitative-minded" so that trends may be seen far ahead and corrected as necessary in ample time to avoid trouble. The farther from home a theater may be, the farther ahead the supply people must see in order to eliminate overages and shortages.

It must be remembered that overages of stock are practically as reprehensible as shortages—the United States cannot afford profligacy.

Thus it becomes clear that a major duty of the supply personnel, from the top down, is to foresee future trends. Anticipation of needs lies considerably in a study of the type of geography and climate of the theater; but in any theater trends must be analyzed early, such analysis to continue steadily throughout a campaign.

This continuous analysis must be applied with great judgment so that peaks and valleys are avoided in the supply pipe as fully as possible. This is true of all types of supply, including the important item of ammunition.

To tie the trained men together with the vast matériel problem we need a high order of leadership in Ordnance, quite as fully as in any other branch or corps. While the results may not be as momentarily spectacular as is the case in a well-led infantry or armor action, it is quite as vital to the success of our arms.

It must be thorough and continuously applied and far-reaching. Above all it must stress the individual leadership over small subordinate organizations and the individual responsibilities of each man. The conception of men as "bodies" has no place in this sort of work, or indeed in any other, if real leadership is to accomplish what it should.

Good organization is of course a great asset in assuming good leadership, and in this connection I want to say something about a rather recent tendency to create very small, highly specialized units, known as "cells," for use in the field.

These cells may include as few as six or eight men and an officer. They are not an integral part of a large organization and must invariably be attached to other units for rations, shelter, discipline, supply, etc.

SINCE the morale of a soldier is strongly dependent on his rations, shelter, and supply, these cells invariably undergo remarkable changes in their morale, depending on how much attention another commander, busy with his own unit, sees fit or has time to give them. So it is clear that cells should be confined only to those types that are really essential, such as the ballistic teams.

The great variety of skills represented in the aggregation of standard Ordnance units of company size should minimize the need for very many cells. Morale will be better, promotions will fall into better line, efficiency will be better preserved, and the jobs should be handled better.

The unfolding of the future steadily presents new types of matériel and improvements in the old types, and their complexities are on the increase from day to day.

Maintenance must keep pace. The guided missiles, the large-caliber field guns, atomic-energy items, and others, must be backed up by trained Ordnancemen, well organized and properly equipped, if they are to assume their real value in defense of the country.

Ready for Action!

NIKE, the first combat-ready guided missile to have its secrecy wraps lifted by the Department of Defense is illustrated on the accompanying pages. The new weapon will be installed in batteries this summer in about a dozen strategic spots to defend key industrial centers. The first will be at Fort Meade, Md., to protect the Baltimore-Washington area.

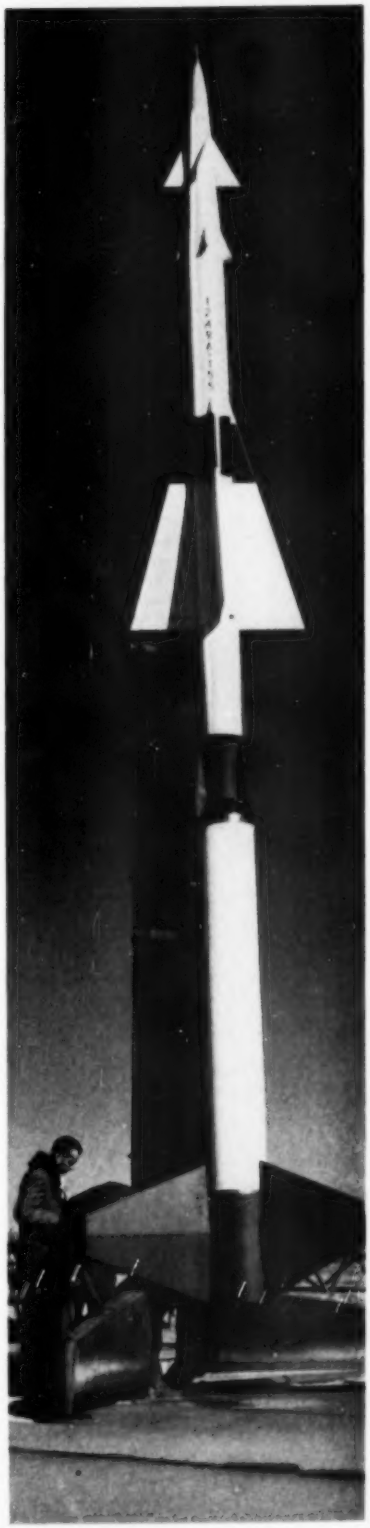
Nike was originally conceived as a controlled antiaircraft rocket projectile. It is a product of the combined efforts of Army Ordnance, working through the Guided Missile Center at Redstone Arsenal, and the airframe, rocket-propulsion, and electronic branches of industry.

It belongs in the Department of Defense family of surface-to-air guided missiles primarily as a defensive weapon to provide greatly increased ranges and altitudes against fast and high-flying modern bombers.

Nike presents a tremendous advance in antiaircraft defense over the present-day batteries of rifled guns. Development started in 1945 in the Bell Telephone Laboratories which made a study at the Army's request. The study showed a surface-to-air missile to be feasible and led to the award of a development contract to Bell Telephone Laboratories. The Douglas Aircraft Company was brought in for the missile-body, launcher, and handling-equipment design.

SUCCESSFUL tests of the missile itself were made in 1946 at the Guided Missile Proving Ground, White Sands, N. Mex., and the complex guidance system was successfully tested in 1951. These trials showed sufficient capabilities to warrant production contracts being placed with Douglas and Western Electric Company for the mechanical and electronic parts, respectively.

Information released on Nike is naturally meager. The missile is about 20 feet long and one foot in diameter. The propulsion unit uses liquid fuel and takes up all space in the missile body not utilized by the guidance units and the "pay load"—an explosive war head. Nike is fired from a launcher by a booster rocket that drops off early in flight. To provide for maximum safety the war head is constructed so that it will explode only when in flight.

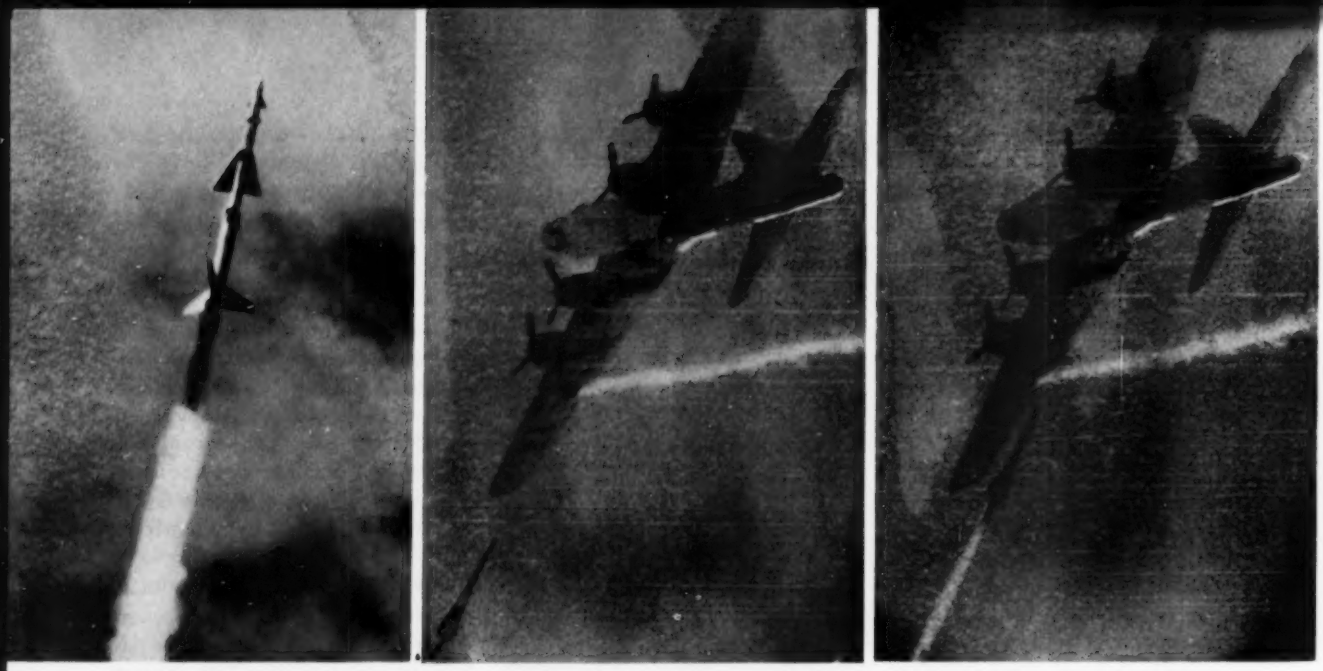


IN the event of an attack on our country by hostile aircraft, the enemy is first picked up on the early-warning radar net. As the attacking airplanes come closer the Nike ground guidance and control system takes over the aërial target and tracks it. At a predetermined position of the target the Nike missile is launched—it converges on the target, intercepts it, and explodes. It is stated that the missile can outmaneuver bombers, fighters, or transports.

Nike is purported to attain a speed in excess of 1,000 feet a second, to be a homing or seeker-type of missile rather than a beam rider, and to have a range of about 35 miles. The cost of the missile has been estimated at from $15,000 to $25,000.

It appears from available information on the Nike system that it can certainly defeat present-day subsonic bombers, but its action against supersonic aircraft has not been reported. The effectiveness of the system is dependent on the efficiency of the radars that track the target and the alertness of the early-warning net that will give approximate locations of attacking aircraft.

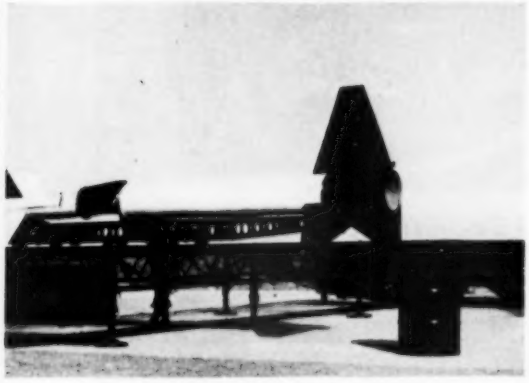
In addition to Nike, other guided missiles are being made public such as the Air Force "Matador" and the Navy's "Regulus"—described briefly as pilotless aircraft with ranges in the 500-mile span—and the "Falcon," an Air Force air-to-air missile which will be the weapon that interceptors can use beyond the range of Nike.



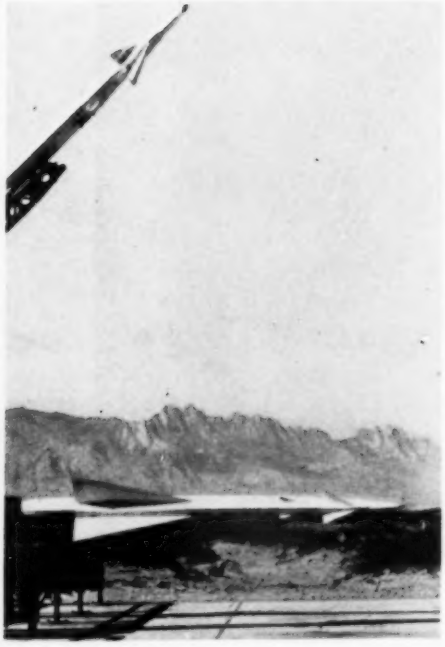
The Nike is shown in action in the remarkable series of photographs above: At left, the missile and its booster rocket just after take-off. Center, the missile approaches the target airplane. Right, the Nike about to make contact with the target.

The complete firing sequence is illustrated on this page. At the right the Nike is shown on its special launcher which begins to elevate it (below) to the firing position as pictured at the left. When the electronic ground control equipment indicates that a target is within range, the Nike is fired (far right), its booster rocket dropping off after speed is attained. The remaining missiles in the battery are ready to fire as soon as other targets approach. Although the Nike is uncannily accurate, its proximity-fuzed war head does not need to make actual contact but will explode when within lethal distance of a hostile aircraft.

Above, left, the Nike intercepts the target and explodes, showing the power of its war head. Center, the target airplane, its wing shattered, bursts into flames. Right, the doomed aircraft plummets toward earth as a starboard engine tears loose.



Official Army photos



Industry Helps Build the Nike

Technicians at Bell Telephone Laboratories, above, operate electronic equipment to simulate flight problems of the Nike, acquiring in a few months data which would normally take years to obtain. Some idea of the complexity of the new weapon system can be had from the wiring and assembly operations on guidance equipment shown below at a Western Electric Company plant.

Armor and the Future

The bullet-resisting, track-laying vehicle is well suited to survive in combat and to serve either offensively or defensively in the highly mobile warfare of the atomic age

Robert J. Icks

This article is from the pen of one of America's best qualified students of tank design, construction, and operation. Colonel Icks served with distinction in the Ordnance Department of the Army during the Second World War where he held assignments of great responsibility in the automotive combat vehicle field. He is an acknowledged authority on the subject.

The accompanying article is based upon a chapter in the manuscript of a book now being written by Colonel Icks entitled "Introduction to Armor." It is hoped that the volume will be completed and published in the near future.
—THE EDITORS.

FOR centuries nine principles have been recognized in the successful conduct of war. The manner of expressing them varies in different countries, but in the United States they are known as the principles of mass, mobility, simplicity, surprise, security, offensive, objective, economy of force, and coöperation.

Although well known, they frequently are ignored in war or interpreted other than strictly. It is upon these nine principles of war that the field of tactics is based.

The principles of tactics have not changed greatly since the beginnings of history. The evolution which has taken place in this field is the result of weapon improvement and technology in general, but the principles themselves remain relatively unchanged.

It is only when these principles are applied under all sorts of physical and geographical conditions and with soldiers varying from the swordsman, the archer, and the horseman to the machine gunner, the paratrooper, and the tanker, that the almost infinite variety of military operations has occurred.

To this variety of conditions, weapons, auxiliary equipment, and personnel must be added the human elements of fear, fatigue, training and experience, jealousies, misunderstandings, anger at a stubborn opponent, false pride, politics and treachery, as well as mechanical failures, vagaries of weather and of time and place. It will be seen, then, that while the principles can be well understood, their application in practice often is unpredictable.

Armor in the United States appears to have reverted to its original World War I rôle of supporting an infantry attack either directly or as dug-in artillery, and the rôle of the mobile independent armored unit seems a thing of the past like its horse-cavalry predecessor. Armored divisions can expect to be allotted piecemeal in support of and attached to infantry units for specific operations.

Korean experience appears to be influencing American tactical thinking in the same restricted fashion as occurred after World War I. Recently there appears to be some agitation, too, toward making every tank commander a commissioned officer in emulation of the Air Force—a system which disregards the principle that rank is an instrument of command and not a matter of property responsibility.

ANOTHER change which seems to have taken place is that the Army no longer emphasizes individual marksmanship as does the Marine Corps where thirty-eight per cent of recruit training is spent on small-arms indoctrination. The Army appears to have accepted the doctrine of volume of fire on the general area of a target rather than our traditional doctrine of selective aimed fire.

To some extent this is true of artillery fire as well, and probably was one of the reasons for the controversial nature of the so-called ammunition shortage in Korea.

The reasons for some of these changes perhaps can be attributed to the futility engendered by the atomic bomb. After the atomic explosions at Hiroshima and Nagasaki the concept of war underwent a stunning change. In the United States it changed to a defensive concept of war by utilizing a single-weapon offense conducted solely by an air force.

After it was learned that America did not alone possess the secret, a wave of hopelessness arose. If ground forces were to be used at all it was felt that they would be powerless against such a terrible weapon and that the resultant necessity for dispersion of forces would be so great that it would remove the ability to fight a decisive action on the ground.

While there were many who were thus completely defeatist, there were those who believed that the principle of weapon superiority would apply in the case of atomic bombs as with any weapon and that the hydrogen bomb would give that superiority until an enemy also created its counterpart or something exceeding its potential. And there were those who believed that while weapons and techniques may change, the application of the principles remains unchanged.

As more and more knowledge of the effects of atomic fission was obtained, the original hopelessness began to give way to a less emotional approach. Although militarily the possession of the secrets of atomic fission or of atomic fusion may result in the same tacit truce regarding its use as resulted from the introduction of lethal gases to warfare, the threat of atomic warfare cannot be ignored any more than it was or is being ignored in the case of gas.

IN the light of more modern knowledge and a reasoned approach it therefore may be well to consider the effects of atomic warfare on the tactics of armor.

There now appears to be relatively little to fear tactically from atomic fission unless within a quarter to a half mile from the center of an air burst. Within that fraction of a mile destruction is quite complete, it is true, but beyond that armor and other troops should survive, and armor at least should be able to enter the destroyed area within minutes and other troops within a slightly longer period.

A ground burst can deny an area for a considerably longer period, but the area of destruction in such a case is likely to be considerably less than a quarter of a mile.

The blast, flash heat, and immediate radiation at the instant of explosion do the killing and destroying—not the aftereffects. With a high air burst there is no residual radiation after a few minutes. With a low air burst the significant residual radiation is not over 400 yards in radius. Food and drinking water outside the destroyed area apparently continue fit for consumption.

Another point of significance is that when employed in rolling, hilly, or mountainous country, even the blast and flash effects are pocketed and may be considerably less than the normal quarter- to half-mile radius.

One point which must be considered tactically is the possibility of "dud" atomic bombs which fail to detonate but which could scatter atomic materials over a fairly wide area. This or deliberately breaking up fissionable material mixed with cobalt would result in scattering material which would remain radioactive over a very long period of time.

In such a case the protection afforded by armor would make armor even more important in atomic warfare than it already is in warfare without fissionable material.

Baby A-bombs and atomic artillery war heads and guided missiles can be considered as having similar but lesser effects. The H-bomb which utilizes atomic fusion instead of atomic fission is of somewhat greater potency than the atomic bomb, having a destructive radius about four times as great.

However, it is less likely to be used tactically, and its development may indeed result in weapon stalemate as in the case of poison gas.

The threat of atomic warfare will result in an even greater dispersion of forces tactically and logistically, but now that those effects are better known even such dispersion is not likely to be as great as once was thought necessary and may affect tactics only in a degree as all weapons which have caused dispersion have done.

Armor is especially well suited to atomic warfare in the protection afforded as well as in its quality of mobility which will enable it to disperse rapidly and to reconcentrate rapidly as changes in the tactical situation take place either through the use of atomic weapons or the threat of such use.

Maintenance and supply problems will be increased through this need for dispersion, and it is likely that alternate supply routes and channels will increase the volume of supplies in the "pipe line"—but that again is a matter of degree and does not change principles.

THE threat of atomic warfare and employment of large concentrations of aircraft will, in the future, require not only greater dispersion but also more consistent operation off roads. Armored divisions will need much maneuver practice in dispersing and reconcentrating rapidly. The closest coöperation with friendly aircraft must be developed, and a highly integrated communications network will be mandatory.

Armored combat engineers and combat bridging will assume great importance in future warfare. Track-laying amphibious envelopments by river will not be uncommon. All these point to the need for abolishing wheeled vehicles in the combat zone and going over completely to tracklayers for both combat and supply.

It seems to the author that atomic bombing is only a matter of degree more effective than normal aërial bombing with high explosives and that much that has been claimed for the effectiveness of aërial bombing must be discounted. For example, the claims of total destruction made by the United States Army Air Force on numerous occasions during World War II were found by the United States Strategic Bombing Survey after the war to have been greatly exaggerated.

Every attempt during the war to gain a decision by air strength alone failed. Even the dropping of the atomic bomb on Japan only hastened the process of surrender for which the Japanese already had begun negotiations. More recently, Operation Strangle in Korea was intended to choke off Communist supplies. But

after many months of effort the Air Force admitted that it was only about thirty per cent effective.

This does not mean that air strength is not important. It is, and highly so, but only when integrated with naval or ground forces or both.

Knowledge of the chain reactions which have made atomic fission possible and are leading to atomic fusion as well, may eventually make possible control over the weather. Since every phase of warfare is influenced by weather conditions, and mud is a mutual enemy, the ability to control weather would give to the side possessing such knowledge a tactical weapon of possibly greater significance than atomic weapons.

It was Napoleon who said, "When lightning can be used, it is better than cannon." The real significance of that statement is becoming more apparent to military men now that weather control is more than a possibility.

Meteorologists for some time have observed and recorded weather; more recently, they have analyzed and forecast it. In the late 1940's American scientists headed by Dr. Irving Langmuir had begun to exercise some form of control over weather by the application of physical forces to the atmosphere.

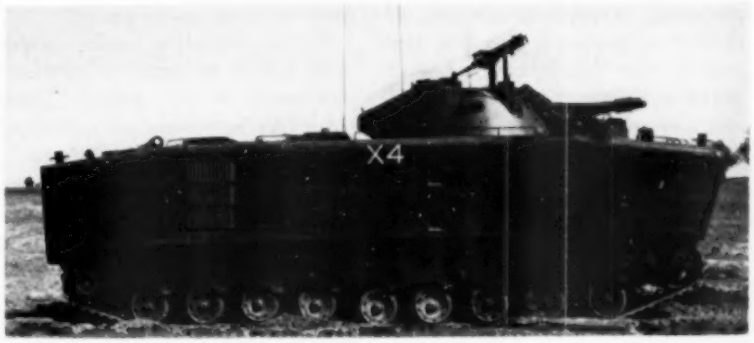
Thus far their researches have indicated that consideration must be given to cloud type, wind flow, available moisture, and numerous other factors. As knowledge increases, many more factors probably will have to be considered. But if and when controls are possible, such ability will become a potent tactical factor.

THE ability to mire supply lines in mud produced by a heavy and continuous rain or thus to disrupt an armored spearhead is one which some day may have to be taken into consideration by the tactician, both offensively and defensively.

The effects on infantry would be great, depending on the season, and the disruption of radar, radio, and other means of communication and the hindering of tactical and strategic air support could be extremely significant. The student of war and of armor must be on the alert for such developments.

Another new field which may have an increasingly greater effect upon warfare in general and on armor in particular is that of operations research, sometimes referred to as operations analysis or weapons systems evaluation.

It aims to predict future operations and to understand and modify them in order to produce different or better results. It differs from ordinary statistical analysis which merely records or analyzes past operations.



Armored and tracked, this new Navy LVT is designed for amphibious operations.

Based on research by F. W. Lanchester in World War I, it was developed first in England early in World War II by P. M. S. Blackett and later in the United States by Ellis Johnson, although countless other individuals in both countries contributed. It is not a science in itself but rather a science combining all sciences.

It employs mathematics from simple arithmetic to advanced mathematics utilizing electronic computers, time-and-motion studies, operational experiments, the significance of fluctuations between action and countermeasure in order to study the possibility of accelerating reaction rate, the determination of chance fluctuations, probability tables, and statistical theory, biology, psychology, and many other tools. As many as possible of the data are converted to mathematical functions.

Past operations are studied to determine the facts, theories are elaborated in order to explain them, and both are used to make predictions about future operations. Constants are arrived at by stripping away details, but the details are added back one by one as modifiers. Decisions are made as to weapons and how to use them. Opinions are omitted, and only facts are plotted.

During World War II the system was employed by the Navy more than by the Army, although study groups now exist in the Navy, the Army, and the Air Force, and in the General Staff as well.

Items like air-to-air combat, convoys versus submarines, bombing techniques against U-boat pens versus convoy escort, the proper depth for exploding depth charges, equipment evaluation, evaluation of enemy countermeasures, and anticipating the point of probable convoy interception by hostile submarines were a few of the effective studies made during World War II.

THE teams which are used in the field vary in content but may include a physicist, a mathematician, a psychologist, and an engineer. These teams cut across normal military channels in order to study, experience, evaluate, and report.

Their reports do not contain recommendations, and the commander to whom they report must add such intangibles as a knowledge of politics, morale, tradition, and judgment normally exercised by an individual having final command responsibility.

A problem interesting to the student of armor was solved in Korea—that of hitting enemy tanks by rocket-firing aircraft. Such rockets could be fired singly, in rapid succession (ripple fire) or simultaneously (salvo fire). The type of fire used had a success rate of 2.5 hits per 100 rockets.

After analysis by an operations research team, another type of fire was

suggested as having a probability of increasing hits to seven per one hundred. When adopted, the suggested possibility was substantiated.

Factors such as accuracy of rockets, size and movement of target, volume of hostile antiaircraft fire, altitude, speed of aircraft, and psychological conditions of the pilot's mind all entered into the computation.

Although at first only simplified components of operations were analyzed in order to produce a pure theoretical analysis, the techniques have since grown and continue to grow. The future may and probably will see operations research bring about greater and greater influence on tactics and possibly even on strategy.

The time may come when an armor commander can have predicted for him the probable course of action of an opponent and his own best course of action as well as the tactics to use.

A future war may bring about a far greater emphasis on night operations than ever before. Some successful night operations have taken place in the past, but many more have been abortive. We know that the Russians particularly have conducted them successfully and now lay great stress on the techniques involved, the major one of which is control.

Near the end of World War II the Germans were beginning to utilize infrared-ray equipment for this purpose. Without doubt the German know-how has been introduced into the Red Army and will continue to grow and expand as a part of the preparation for such operations.

IN the application of these techniques and the training necessary to conduct such operations successfully, armor will be involved. Infrared detection devices can be circumvented partially by such means as ray-absorbent paints, so both offensive and defensive means must be considered and applied by those interested in armor.

Electronic recognition signal devices similar to those used by ships and aircraft may become a necessity for armor in the future.

Radar and television likewise will play their part in control, the former for detecting hostile planes and armor and for fire control, the latter to augment aërial and personal reconnaissance as well as for training and briefing.

Facsimile transmission by wire or radio of photographs, maps, and orders may also play a part in control of operations, as may wire recorders or plastic-band recording devices which would be useful for recording data accumulated during reconnaissance either from the air or on the ground.

Airborne warfare or vertical envelopment is likely to become of increasing importance in the future. Troops trained for such operations in the past often have been in need of support by relatively rapid link-up with conventional ground forces.

With the possibility of utilizing lighter metals and lighter weapons,

such units will possess greater tactical strength and more sustained power by being able to carry their own armor and heavier-calibered weapons with them, eliminating the urgent need for the quick link-up which has existed up to now.

The Army and the Air Force have done and are doing a great deal of work in connection with the development of skills and equipment for this type of warfare and may be counted upon to do a great deal more. Conventional heavier-than-air craft are used by the Army and Air Force for these purposes, while in the Marine Corps techniques and equipment are being developed for drops of shorter distances by means of the twin-rotor Piasecki helicopter.

During World War II, liaison aircraft basically were assigned to armored division artillery, and their availability to armor itself was sporadic. Today they are available to all combat units in the division.

It may well be that this system will receive an impetus through the means of small one-man helicopters. As a matter of fact, the commanders of even the smaller armored units may be able to carry out personal reconnaissance and actual control in combat by such means as this.

From the tactical as well as the strategic standpoint the possibility of water-borne envelopments by armor from submarine carriers is not too far-fetched. One of the most interesting devices of World War II was the fleet of five Japanese submarine seaplane carriers, each capable of carrying in a large deck blister three seaplanes with wings folded back, together with parts for five more. The planes were launched by a deck launcher and picked up by a deck crane and returned to their storage space.

SUCH a submarine would be large enough to carry an entire light tank company or half a medium tank company. A surprise amphibious landing coördinated with an airborne landing and followed up by subsequent airborne and seaborne operations is well within the realm of possibility.

Guided missiles and atomic artillery will perform tactically the same as conventional artillery and tactical air support, and will be integrated with other fire support. Such weapons are expensive and require elaborate control systems. Fast-moving armor will be but fleeting targets for such weapons although static concentrations of armor will certainly need to fear them.

Robot tanks to spearhead armored attacks and to cause an enemy to disclose his defenses surely will come into existence in the not-too-distant future.

And unquestionably in the future there will be drone tanks, radio-controlled and Geiger-counter-equipped, the counters being observed by television cameras in the vehicles and televised to command tanks so that the radioactivity in an atom-blasted area can be determined from a distance.

The possibilities of armored warfare are far from exhausted. There presently is a tendency to emphasize the principles of mass, security, offensive, and coöperation and to ignore those of mobility, simplicity, surprise, objective, and economy of force.

In a future war, initially we may be forced to assume the defensive, but our planning and thinking must not degenerate into a defensive mentality. As long as audacity and mobility of mind do not die, armor can and will be used to great effect for a long time to come.

Technical Manpower

The increased complexity of modern weapons demands many more trained engineers and technicians to maintain and operate them, and several possible solutions to the problem are proposed here

Ralph F. Baxter

IN the maintenance, operation, and use of modern weapons we are urgently concerned with the shortage of personnel possessing the necessary training and technical skill demanded by the present level of weapons technology.

In seeking a solution to the inadequate supply of engineers and technicians, three broad avenues of approach are recognized. Simplification of our weapons system is one. Another is the improved utilization of the available manpower, while the third is to secure more trained personnel.

Our weapons are, beyond question, becoming increasingly complex. This trend imposes growing demands on our national production potential, our fiscal stability, and our technological manpower. Consequently the entire civilian economy and our whole way of life may, by attrition, become endangered.

IN the planning for total mobilization, these complexities appear to present a formidable menace to the effectiveness of our defenses. Foremost among the factors limiting the build-up of military forces is the shortage of trained and experienced technical manpower, and national preparedness demands that we develop a program to solve this problem.

Complexities of military armaments which tax the capabilities of a nation are not entirely new to mankind. Since the Paleolithic age, when man first fashioned weapons from chipped stone, until the present era, the implements of war have become increasingly intricate. In the past, the demand for improved armament has often pressed a whole civilization toward scientific progress, new industries, and economic evolutions.

This is the winning essay of the James L. Walsh Memorial Essay Contest, established by the American Ordnance Association in memory of the late Col. James L. Walsh, founder and first editor of ORDNANCE *magazine and a former president of the Association. Mr. Baxter, winner of the 1953 contest, is a project engineer in the research and development laboratory of Rheem Manufacturing Company, Downey, Calif.*

The prize of $1,000 is made to a member of the Association who has not reached his thirtieth birthday and who submits the best essay on an assigned subject. The subject of the 1953 essay was:

"It is sometimes said that modern weapons have become so complex that their use and maintenance can be assured only by engineers and technicians of more than average skills. Discuss the truth of this opinion in the light of manpower limitations and what steps might be taken to assist in the solution of the problem."

The award was formally presented to Mr. Baxter at the Annual Industrial Preparedness Dinner Meeting held in the Grand Ballroom of the Waldorf-Astoria, New York City, December 2, 1953.

THE driving force behind our present technical progress is also military necessity. In the present world situation, our grand strategy, involving an adequate level of defense without sacrificing the national standard of living, hinges on weapons superiority.

It is largely this dependency on superiority which is resulting in the design of weapons with broader missions and increased complexities. The danger which appears particularly threatening is the possibility that our technical progress in design of armaments will outstrip our existing capacity to provide the competent personnel to employ the weapons on an effective scale.

No formula of strategy, tactics, or science can arbitrarily simplify our weapons, just as no attempt to restore our modern civilization to the simpler ways of past generations can be successful. The simplification of weapons systems must then start with the elimination of any unwarranted complexities.

The extent to which simplification of weapons is possible, and to what complementary extent manpower must be procured to handle the essential op-

erations, can best be evaluated by considering the weapons systems we are dealing with and the development and philosophy of armaments as these affect the manpower requirements.

Almost every weapons system centers around a series of fundamental components essential to the accomplishment of the assigned mission. These fundamental components are the pay load, the power plant, the control system to direct or guide, and the weapons platform.

These functional requirements of a modern weapon, it can be shown, prevent any such system from ever becoming simple to operate. Therefore, to man these armaments will continue to require skilled technical personnel.

In addition to the above mission-imposed complexities, others are imposed on our designs as a result of our military philosophy, our design habits, and our technological limitations. Evaluating them individually will show some means of simplification.

In the American military philosophy, two factors particularly influence weapons design. First is the standing presumption that any war we engage in will be a defensive war. Secondly is the high value that is placed on the individual human life. Both precepts are reflections of our democratic society, in which our military planning and grand strategy are subservient to the policies of a popularly elected administration.

THE influence of public opinion and sentiment, unschooled in strategy or logistics, imposes, on occasions, policies which on their military merits alone might not be prudent. This is a price paid for the overwhelming number of other benefits derived from our democratic government.

In consequence of our chosen defensive rôle at the outset of any potential conflict, our weapons are designed to be capable of use anywhere in the world. This requirement alone, which would not be applicable to all our weapons if we could choose the location of our campaigns, adds complications to their design.

No answer short of aggression, an alternative abhorrent to our national conscience, will remove this handicap. As a result, these requirements have to be considered in our planning.

The second precept, our high esteem for the individual human life, has even broader implications. It is recognized that a degree of complexity in our modern weapons is due to our concern for the safety and often the personal comfort of our own forces. No effort is spared to achieve a maximum safety level, making our weapons safe to operate, handle, and transport under every conceivable circumstance.

However, there can, in many instances, be found an optimum safety level at which the risks run due to the reduction of safety factors and devices from the maximum safety level would be more than offset by the reduction in personal risk due to the tactical and logistic advantages gained.

Similarly, the ultimate in comfort or convenience may not represent the optimum weapon.

Our potential enemies, with vast resources of manpower and complete disregard of human life, are able to design their weapons to an optimum point of effectiveness, completely neglecting the lives involved. We do not believe in such an approach.

In order to save our own forces from avoidable casualties, while maintaining their tactical effectiveness, it is not only desirable but imperative that we strive to design armaments which attain an optimum combination of tactical effectiveness and safety. A potential source of malfunction can be approached statistically to determine the odds of such a failure causing a casualty.

This probability can be compared with the possibility that the tactical and logistic advantages gained through simplification, due to the removal of a safety device, will, in operation, save casualties. The outcome of such a study, employing the techniques of operations research, will indicate an optimum design.

Only in very recent years has a serious attempt been made to weigh and evaluate mathematically the multiple factors entering into the effectiveness of a weapon. These techniques are open to much further refinement and broadened application. They represent the most concrete step from intuitive and emotional designing toward a true optimum design.

It is recognized that such a policy of optimum design might be difficult, at first, to sell to the public and would probably face the same criticism as did the tactics of the late Gen. George S. Patton, Jr. It may be recollected that his daring attacks were vigorously defended as being justified because the high initial casualties were more than offset by the lives saved by the rapid attainment of an objective.

A SIMILAR principle applies to weapons where lighter weight and simpler operation, may, in many cases gain lifesaving tactical advantages to more than offset the losses due to an occasional malfunction.

Admittedly this principle is controversial, but in the light of the magnitude of the problem it is advocated, in instances where rigorous safety standards impose major complexities and resultant loss of tactical effectiveness, that the principle of an optimum safety level be applied.

Other factors which add avoidable complications are habit and ignorance. To a certain extent these overlapping influences are most prominently found in the specifications of a weapon. The majority of specifications are, of course, justified and necessary, but sheer force of habit frequently leads to the inclusion of some which careful individual consideration would eliminate.

A few examples of needless requirements include: excessive fatigue-strength requirements for single-mission items; storage life considerably beyond the point of obsolescence; transportation vibration tests for entire items normally transported only as components.

In most cases these are standards, set up by the cognizant service or prime contractor, which are misapplied to items which were not contemplated when the requirements were initially devised.

It is urgent, therefore, that review of all standard requirements be made to

eliminate unnecessary ones, resulting in simplified design and operation.

In addition to habit, ignorance or lack of comprehension imposes unwarranted complexities. Whenever the limitations of accurate scientific knowledge and experience result in an indeterminate problem, the engineer will tend to overdesign just to be safe.

The process of overdesigning is, unfortunately, not a rare occurrence. It is prevalent, especially, in rush projects where there is insufficient time for research and development.

This is contrary to the common fallacy which believes that extended research inevitably leads to increased complications. In the absence of concrete knowledge, under the guise of design safety factors and margins of error, attachments, gadgets, duplications, and weight are added. Thus the only basic solution to overdesign is better understanding.

ANY consideration of the influence of overdesign on the complexity of weapons inevitably raises a question regarding the relative status of research, applied research, and development.

In simplified concepts, development represents the applications of known components and materials, applied research consists of developing new components using ingredients with known basic characteristics, and pure research seeks to determine the fundamental characteristics of an item, both qualitatively and quantitatively.

To simplify a system's operation, the more penetrating the knowledge of it the more likely will an improved method of accomplishing a required result be devised. Consequently, research applied to such a system can be enormously useful in improving the design and performance of a weapon.

To be useful, however, basic research must be directed toward carefully selected problems and be organized on a long-term basis. The disrepute, which from time to time clouds the reputation of research, is usually based on instances of misdirected and abstract wandering into fields totally unrelated to military development.

In the United States we have, for many years, lagged behind other nations in many phases of basic research while leading in most fields of applied research and development. Much of the fundamental work on nuclear physics, rocket propulsion, and jet engines was accomplished in Europe by nations with infinitely smaller resources than those of this country.

Ralph F. Baxter
Winner of Walsh Memorial Essay Contest

The prudence of allowing the dependence on foreign research to continue is open to grave questioning. In the defense effort we cannot afford to neglect the basic research required for the development of new, simpler, and more effective weapons.

Having dealt with the avoidable complexities of weapons—discussing the part that our military philosophy plays and the extent to which habit and lack of knowledge contribute to their accumulation—it becomes clear that, despite a great potential for simplification, modern weapons will always remain complex. Weapons systems, like modern machinery, will continue to require skilled, trained, and experienced technical personnel for their operation, maintenance, and repair.

TECHNICAL ability, training, and experience, individually, are not adequate to fill the manpower need. Consequently a combination of these attributes is required.

To man the modern weapons, more technically educated men are needed, and these men, with the basic technical schooling, must be trained in specialized skills. Recognizing this need, the services today are taking many drafted graduate engineers and scientists and sending them to specialized service schools only to find that too soon after their training is completed, and just when they have acquired some valuable experience, their period of service terminates.

The solution to such a predicament has many precedents in the armed forces. The Medical Corps, the Army Engineeers, and other specialized units were formed in answer to a need for highly trained personnel.

A corps of professional scientists and technicians is needed now to provide a nucleus around which less skilled men can be organized, forming competent teams to handle the complex weapons. The investment of time and training in these career men would bring high returns in efficiency.

Members of this corps would be obligated to serve a number of years after completion of their training, and even should they later decide to leave the service their specialization would almost certainly draw many of them to the defense industries.

The armed forces would thus continue to benefit, although indirectly, from their knowledge and experience.

NO practically attainable number of trained personnel will ever fill every manpower need unless efficient use is made of their skills. There are several ways of achieving this.

To reach a satisfactory level of efficiency it will be imperative to specialize the training of technical personnel to a single family of weapons or to a single group of components.

Another method by which the effectiveness of trained personnel can be stretched is improved standardization of weapons. The frequent model changes, short-run production, and continuous engineering changes, found principally in the aircraft and missile industries, intensify the problem of operating, servicing, and maintaining any item in the field.

Both the production and operational

phases of the defense effort might well gain if in some instances, after completion of their initial development, the subsequent improvements and design changes were accumulated for a model revision rather than fed piecemeal into the production lines.

By enabling engineers and technicians to become accustomed to standard models their capacity to operate and service the weapons would be increased.

EVEN weapons simplification and better utilization of existing manpower will not be adequate to assure the use and maintenance of our defenses. There remains the third approach—to provide more engineers and technicians. A program to this effect has been in existence for about three years, sparked by the demand of industry for more graduate engineers.

The results, showing an increase in the enrollment at engineering schools, are encouraging but far from satisfactory. The low birth rate of the middle 1930's now shows up. Fewer men are in the college age group, and national enrollments are tapering off.

To aggravate the shortage of engineering students, many potential students are discouraged by the high standards set for engineers in many of our colleges, and others switch to less demanding courses after a year or two of trying to make the grade.

Many of these discouraged and disillusioned students are capable of acquiring technical skills. The colleges, seeking to train creative engineers and scientists, are overlooking the need for skilled but uninspired, competent but not brilliant engineers.

Without diluting their high standards of training, much needed in the fields of research and design, additional manpower can be procured by setting separate courses for operating engineers.

The stress of this curriculum would be on thorough comprehension of basic sciences, reduced requirements on mathematical and creative ability, and a very thorough training in mechanics, electronics, or the other fields in which the engineer would be required to perform professional-level operations and supervision.

The foregoing discussion leads to an approach to the solution of the shortage of trained manpower to operate our increasingly complex weapons. It has been emphasized that no half-hearted program is likely to show the magnitude of results which the urgency of the situation seems to demand.

A number of steps, in combination, are proposed to extend the existing manpower and to increase the future supply. A 6-point program follows, outling what is believed to be a logical and practical approach toward the solution, or at least the containment, of the skilled technical manpower shortage:

1. The establishment of weapons review boards comprised of military, logistic, scientific, and production representatives. The function of these boards would be to sit in continuous review of all major weapons systems. Each board, specializing in a family of weapons systems, would review, in the light of the latest military and scientific knowledge, all the specifications and requirements imposed upon a weapon.

On their own initiative, or acting in answer to proposals from contractors and interested parties, the review boards would aim at determining feasible simplification through the waiving of unwarranted or unnecessary design, production, or handling requirements.

2. The establishment of a service academy specifically devoted to the training of professional technical officers. By offering a specialized technical education, a commission, and a career in exchange for a commitment of several years of active service after graduation, outstandingly qualified cadets can be attracted.

3. The establishment of a planned long-term program of basic research into carefully selected areas. This program would have a dual objective. First, to perform basic research into areas close to the major physical problems confronting engineers in their development of weapons; secondly, to train more men in the basic sciences.

4. The establishment of a program for college students, paralleling the R.O.T.C. and N.R.O.T.C., devoted to training students in the technical colleges in the application of the sciences to weapons. Such a program would include specialized courses in basic concepts of weapons or components with which the student would be concerned when called to active service.

5. The establishment of long-term enlistments for men to be sent to technician-training courses and incentive pay and ratings based on technical qualifications.

6. The establishment of engineering college curricula to attract men interested in noncreative engineering.

"In the American military philosophy, two factors particularly influence weapons design. First is the standing presumption that any war we engage in will be a defensive war. Secondly is the high value that is placed on the individual human life.

"Both precepts are reflections of our democratic society in which our military planning and grand strategy are subservient to the policies of a popularly elected administration. . .

"In consequence of our chosen defensive rôle at the outset of any potential conflict, our weapons are designed to be capable of use anywhere in the world. This requirement alone, which would not be applicable to all our weapons if we could choose the location of our campaigns, adds complications to their design."

IT has been shown that increasingly complex weapons require an increasing supply of trained technical manpower. This personnel is not readily available in adequate numbers. Thus it is imperative to plan some means of manning our armaments.

The program proposed provides for steps to reduce the manpower required to operate the weapons by simplifying them and provides policies to assure an improving supply of the necessary technical personnel.

The security of our country, resting on the effectiveness with which we can apply our weapons, demands that some positive program with the specified objectives be adopted.

Adm. W. H. P. Blandy, 1890-1954

The American Ordnance Association announces with profound sorrow the death of its distinguished vice-president and director, Adm. W. H. P. Blandy, at New York City on January 12, 1954.

THE AMERICAN ORDNANCE ASSOCIATION announces with deep sorrow the death of its distinguished and beloved vice-president and director, Adm. William Henry Purnell Blandy, U.S.N., Retired, at New York on January 12, 1954. Scholar, engineer, proponent of invincible seapower, and revered leader of men, he served the Nation and the Navy with outstanding success in assignments of vast responsibility during more than thirty years. He had been a member of the Board of Directors of the American Ordnance Association since 1953 and was elected a vice-president in the same year.

Admiral Blandy was graduated No. 1 in his class at the United States Naval Academy in 1913, was commissioned an ensign in the Navy in that year, and advanced through grades to the rank of admiral in 1947.

As Chief of the Bureau of Ordnance of the Navy from February 1941 to December 1943 his direction of that important assignment was notable for the close coöperation between the Ordnance organizations of the Navy and the Army.

He was made commander of Amphibious Group No. 1 in January 1944 and participated in the capture of Kwajalein, Saipan, Palau, Iwo Jima, and Okinawa. He commanded cruisers and destroyers of the Pacific Fleet in 1945. During 1946 he became Deputy Chief of Naval Operations for Special Weapons, which assignment he served as commander of Joint Army-Navy Task Force One which planned and conducted the atomic bomb tests at Bikini.

Later he commanded the Eighth Fleet in the Atlantic and became Commander in Chief of the Atlantic Fleet in 1947. He retired from active naval service in 1950 and became president of the Health Information Foundation, New York City.

Decorated with the Distinguished Service Medal with three stars, Admiral Blandy was also Grand Officer, Order of the Southern Cross (Brazil); and Commander, Order of the British Empire. In 1944 he was awarded the American Ordnance Association's Frank A. Scott Gold Medal for Distinguished Ordnance Service, and in 1950 the Cincinnati Post of the Association awarded him its Charles L. Harrison Gold Medal.

In 1951 the Association founded the Blandy Gold Medal in tribute to his renowned service for ordnance development and especially the coöperative efforts between the Navy and Army Ordnance organizations.

While grieving at the loss of this outstanding patriot, the American Ordnance Association takes pride in the sterling qualities of his leadership which contributed so greatly to the progress of our national defense.—L.A.C.

Industrial Teamwork

Small manufacturers pooling their facilities for the production of ordnance may be the modern answer to the pressing problem of industrial dispersion to safeguard the national defense

Nelson Anderson

FIVE million 3.5-inch high-explosive antitank rocket heads have been manufactured and delivered to the United States armed forces since mid-1949. Contained in that statistic of this very effective tank killer, proved in combat by the United Nations forces in Korea, is a story of coöperation and accomplishment by two relatively small organizations, Hubeny Brothers, Inc., of Roselle, N. J., and Eastern Tool & Manufacturing Company, of Belleville, N. J., with a total working force of less than a thousand persons.

These companies learned to work together as a well-knit, coördinated team, applying their engineering brains, their equipment, and their skilled manpower to a single aim—quantity production of rocket heads.

Before production could begin, however, many difficulties had to be overcome, principally those arising out of close-tolerance requirements, both in component manufacture and final assembly of the heads.

ALL the preliminary engineering and development work was undertaken and accomplished upon the initiative of these firms and without the aid of Government-owned or leased equipment, a very important factor in keeping down the total cost to the Government.

In addition, the contracts for rocket-head delivery were bid and won on a competitive basis or "open contract."

Mr. Anderson is vice-president of the Eastern Tool & Manufacturing Company, Belleville, N. J. He has been closely connected with the development of rocket design, serving as project engineer in the manufacture of the first 3.5-inch rocket models.

This is a graphic demonstration of the value of the small contractor to the ordnance procurement program. Weight of numbers makes his production potential the most important reservoir of ordnance output, and teamwork turns this potential into reality.

Early in the Korean conflict, when Red tanks were overrunning our undermanned defenses, it became very apparent that a larger caliber antitank bazooka round with greater penetrating power was needed, and needed in a hurry. Hubeny and Eastern were just then getting into quantity production on the 3.5-inch antitank rocket head, so small quantities of the assembled rockets were flown directly to Korea and, with hastily devised launchers, immediately proved a success, being able to assure penetration of the heavy armor of the enemy tanks, something that the smaller caliber bazooka then in general use had not been able to do.

For quite some time subsequent to this, until the normal pipe lines of ordnance supply could be filled, 3.5-inch rockets reached Korea via air.

Hubeny Brothers, Inc., is the prime contractor of this production team, delivering the complete rocket heads assembled, while Eastern Tool & Manufacturing Company makes the head's components—the steel ogive, or nose, the head body, and the copper cone or liner.

THESE two organizations, while both engage in metal manufacturing, are miles apart as to peacetime end products—Eastern producing a large variety of wire and metal products used in almost every industry while Hubeny manufactures metal kitchen cabinets.

Knowing each other's capabilities, however, these two firms decided to pool their talents, resources, and experience in the manufacture of rocket heads. How well they succeeded as an effective unit is outlined here.

Previous to starting this operation, neither firm was a stranger to ordnance manufacture, Hubeny having made 37-mm. shells, practice bombs, rockets, range-finder parts, and 20-mm. feeder mechanisms during World War II, earning in the process a U. S. Navy Certificate of Achievement.

During the same period, Eastern manufactured components for fuzes, for ammunition containers, and for mortar and artillery ammunition, being awarded four Army-Navy E's for production excellence.

The original models of the 3.5-inch rocket head were designed and developed from ordnance specifications by Eastern in 1944. This was essentially the same head being produced in large quantity today. The first trial production lot of 3,500 complete rockets, head and motor assemblies, was manufactured by this firm in 1944.

Hubeny Brothers is the oldest successful quantity producer of 3.5-inch high-explosive antitank rocket-head assemblies. It was recently turning out approximately 8,000 finished units a day on a 2-shift basis and working on its sixth contract.

In 1949 rocket heads were new to Hubeny but appeared basically to be a series of routine assembly operations involving a sheet-metal structure of reasonably simple construction. However, specification requirements on the maintenance of copper-cone hardness complicated the process and made necessary research into an improved heat-assembly method.

INDUCTION heating was used initially, employing first the single- and then the 2-shot method. Heads assembled by these means failed to pass the internal pressure test, due, it was found, to the difference in the coefficients of expansion of copper and steel which made it very difficult to hold the copper cone in exact alignment with the undercut of the body. Subsequently, an external pressure test was added to the foregoing.

The Hubeny people suggested to Ordnance authorities that, if the anneal of the cone might no longer be a requirement, gas, as a medium of heat, could be the solution. Shortly afterward it was decided that critical copper-cone hardness was no longer a necessity, and this immediately opened the door to the use of gas or acetylene as a means of heating these assemblies.

A test fixture employing gas and air was designed and built, making it possible not only to soak the copper cone to avoid conduction of heat away from the body but simultaneously to soak the body sufficiently to produce a desired brazing condition.

These tests proved successful, so Hubeny built a battery of multiple-type assembly units which are still in use.

Another production obstacle arose relative to the silver soldering of the union to the body. It was found in assembling the rocket head to the motor at the arsenal that the torque applied in tightening the head to the motor twisted some of the unions loose, although they had passed both external and internal pressure tests.

Accordingly, a torque test of one hundred foot-pounds was specified for every assembly before painting. Results of this test proved good but resulted in some deformation or twisting of the neck of the union, so it was discontinued.

Hubeny and Eastern engineers, working together on the problem, concluded that normal machining tolerances were apt to cause a poor fit, resulting in some deficient joints. The cost of maintaining close machine tolerances for the mating parts of the head precluded this possibility, so a foolproof and economical means of controlling dimensions for these parts was deemed necessary.

Shrink fit of the union to the body was tried and proved a success. This involves heating the neck of the body to expand it and then putting the cold union, with a silver-solder ring in a groove made for the purpose, in place until cooling and shrinkage has occurred.

The assemblies are then permitted to cool to room temperature with the silver-solder ring still unmelted, due to the chilling effect of the cold union contacting the neck of the body. Then the assembly is induction-heated to complete the union. The methods thus devised have been proved in the output of millions of heads.

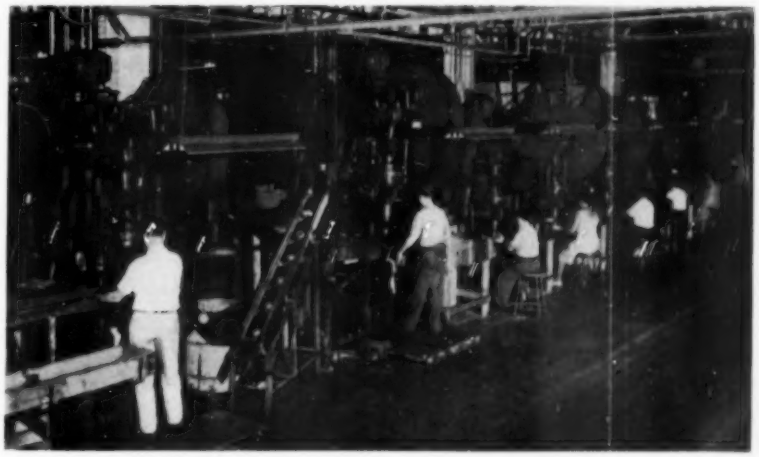
Hubeny ordnance production today is by no means limited to 3.5-inch rocket heads. Rocket motors and rocket heads of other sizes are coming off their assembly lines. In addition, they are now setting up for the production of items still on the classified list.

COMPONENT-PART manufacture for 3.5-inch rocket heads was at first presented with formidable production difficulties, concentrated principally in the copper cone, since specifications required the maintenance of very close wall tolerances. To produce these component parts in quantity was Eastern's part of the job.

Approaching the problems of cone manufacture, it was easy to see that machining was not the answer, since it was too costly, too wasteful of materials, and, above all, too slow. Deep-drawing offered the best available answer but did not yet meet all requirements since the process, as usually practiced, involved annealing between the various drawing steps to control wall tolerances and prevent fracturing or tearing of the metal.

This process is time-consuming and involves the use of extra equipment.

Press line for 3.5-inch rocket head copper cones at Eastern Tool Company.



Eastern engineers and tool designers finally arrived at the solution after extensive research and after exploring different tool and die design possibilities involving the reactions of copper to various drawing steps.

It was found that the first draw was the all-important step, where the first copper cup is drawn from the flat strip. At this point the height of the draw depends, ratiowise, upon the diameter of the object drawn and the thickness of the metal.

Nine separate press operations, from the first draw cup to the final coining and trimming, are required, but since the annealing process between each press operation is not necessary, material can move uninterruptedly from one press to the next in a constant flow. As perfected, this is actually a stepping operation, rather than deep-drawing, since in each successive step the metal is caused to flow into position concurrent to the direction from which the force is applied.

WITH the precision deep-drawing of the copper cone an accomplished fact, the problem of production speed was essentially solved. One line of presses, none of more than 200 tons' capacity, can turn out approximately 12,000 cones per shift at the Eastern plant.

What both members lack in size when compared with the industrial giants is compensated for by the resultant adaptability and versatility to design change-over. Equipment employed is light, lending itself to quick production changes, if necessary, without requiring drastic alterations of the existing setup or great loss of working time.

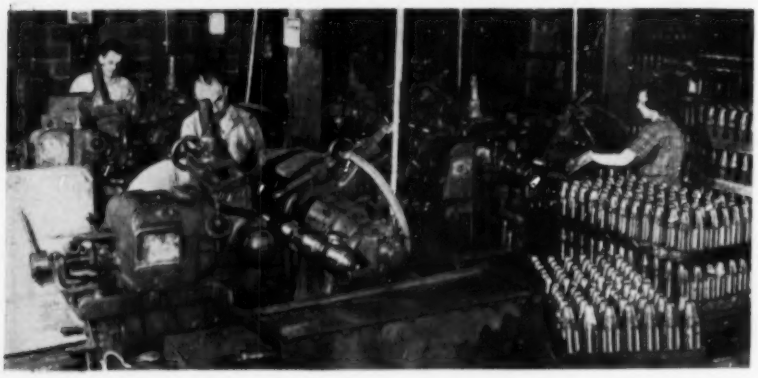
The two firms are currently engaged, in addition to their present output, in research and development work concerned with new items for ordnance. This is being carried on both together and independently, depending upon the specific item.

The two plants are situated about ten miles apart. A constant flow of information on materials, production rates, and other pertinent data is mutually supplied by each member, the vice-president of Eastern meeting at frequent intervals with John and Anthony Hubeny of the Roselle firm. Similarly, they make it a point to attend together forums and conferences conducted by the various ordnance agencies of the Government on new designs, materials, etc., as part of their program of coördinated self-help.

When problems arise, such as the need for a specific material to keep production rolling at one of the plants, both parties get to work and locate the material, combining forces for greater and faster coverage. Naturally the constant flow of production between plants is of prime importance in maintaining schedules, so a strict delivery plan is adhered to, with the receiving member being notified well in advance of any possible discrepancy.

The spirit of teamwork shown by these firms has not been confined to themselves alone. Both have repeatedly given freely of their experience and the results of their research to help competing firms set up for similar production.

Centerless grinding operations at the Hubeny Brothers plant.



The organizations aided in this fashion, it might be added here, are among the largest in the country. This has undoubtedly saved untold time and expense for the ordnance procurement program and helped assure delivery of the goods where and when needed. A coöperative spirit of this sort among small producers is widespread but not generally publicized.

None of the manufacturing achievements chronicled here would have been possible without the aid and guidance of the personnel of the New York Ordnance District, the Office of the Chief of Ordnance, and the arsenals, under whose supervision these contracts are being fulfilled. Willing, able, and experienced, they have never failed to respond when needed.

If there is a moral to all this it certainly must be that small manufacturers, with their experience, inventiveness, and certainly with their numbers, are the real backbone of the ordnance production program in this country. Brains, know-how, and ability are not confined to the large producers.

The small manufacturer exists and prospers because in most cases he can and does adapt his equipment setup to a variety of products and situations. Joining forces, working together, utilizing to the fullest the machinery, tools, and trained manpower they already possess, small manufacturers can deliver a great many ordnance items at a competitive price, if not cheaper, than the large concern and just as fast.

THE present state of international affairs and the danger of atomic attack upon our industrial centers from the air places emphasis upon an effective defense against such a disaster.

The history of the effects of saturation bombing during World War II indicates that industrial producers presenting a dispersed target generally survived and continued operations, while the big centralized establishments were in many instances obliterated.

What fits this formula of dispersion for defense better than scattered small manufacturers, working together, yet so spread out as to prevent the enemy from wiping them out in a single attack?

Organization of the Army

A summary of the recommendations of the committee appointed by the Secretary of the Army to advise on ways and means of strengthening the organization of the Army to achieve its mission

LAST August Secretary of the Army Robert T. Stevens appointed a 5-man committee to review the organization of the Army and to advise on methods of strengthening the organization to meet its national-security mission.

This report was released on January 14, 1954. Published below is a summary of the committee's recommendations and the highlights of its suggestions for improving the organization of supply management.

Improving Top Management.—To add effectiveness to the exercise of his authority and to make the position of Secretary of the Army more attractive to men of outstanding competence, we recommend four actions:

1. The Secretary be given opportunity to participate actively in the formulation by the Secretary of Defense of basic policies guiding the Department of the Army.

2. The Secretary be permitted to attend, as a regular observer, meetings of the National Security Council so that he may be informed of basic national decisions.

3. Efforts be made to insure that his authority is respected by those above and below.

4. His continuing responsibility be reaffirmed for the affairs of the Department. Specifically, in emergency situations, when the Secretary of Defense communicates directly with the Chief of Staff, it should be made clear that the Chief of Staff is acting for the Secretary of the Army and is wholly accountable to him.

FIVE steps are recommended to strengthen civilian control in the Army:

1. The position of Under Secretary be abolished and a position of Deputy Secretary be created. Its incumbent should be freed of responsibility for the supervision of the major functional areas—men, money, or matériel. He should serve as the Secretary's intimate associate and deputy in the general management of the Department.

2. The rôles of the Assistant Secretaries should be redefined. Their basic responsibility is "functional supervision." Their task is to guide actively the Army's operations by formulating objectives and policies and evaluating performance—not to assume responsibility for day-to-day operations.

3. An additional position as Assistant Secretary should be established. The Secretary needs sufficient able civilian assistants to exercise effective control in three basic areas—men, money, and matériel. Creation of the additional position will permit one of these assistants to concentrate on financial management.

4. The Assistant Secretary for Financial Management should be responsible for the active, forceful, functional supervision of the Army's financial affairs. The Comptroller of the Army should be a military man and should continue to report directly to the Chief of Staff.

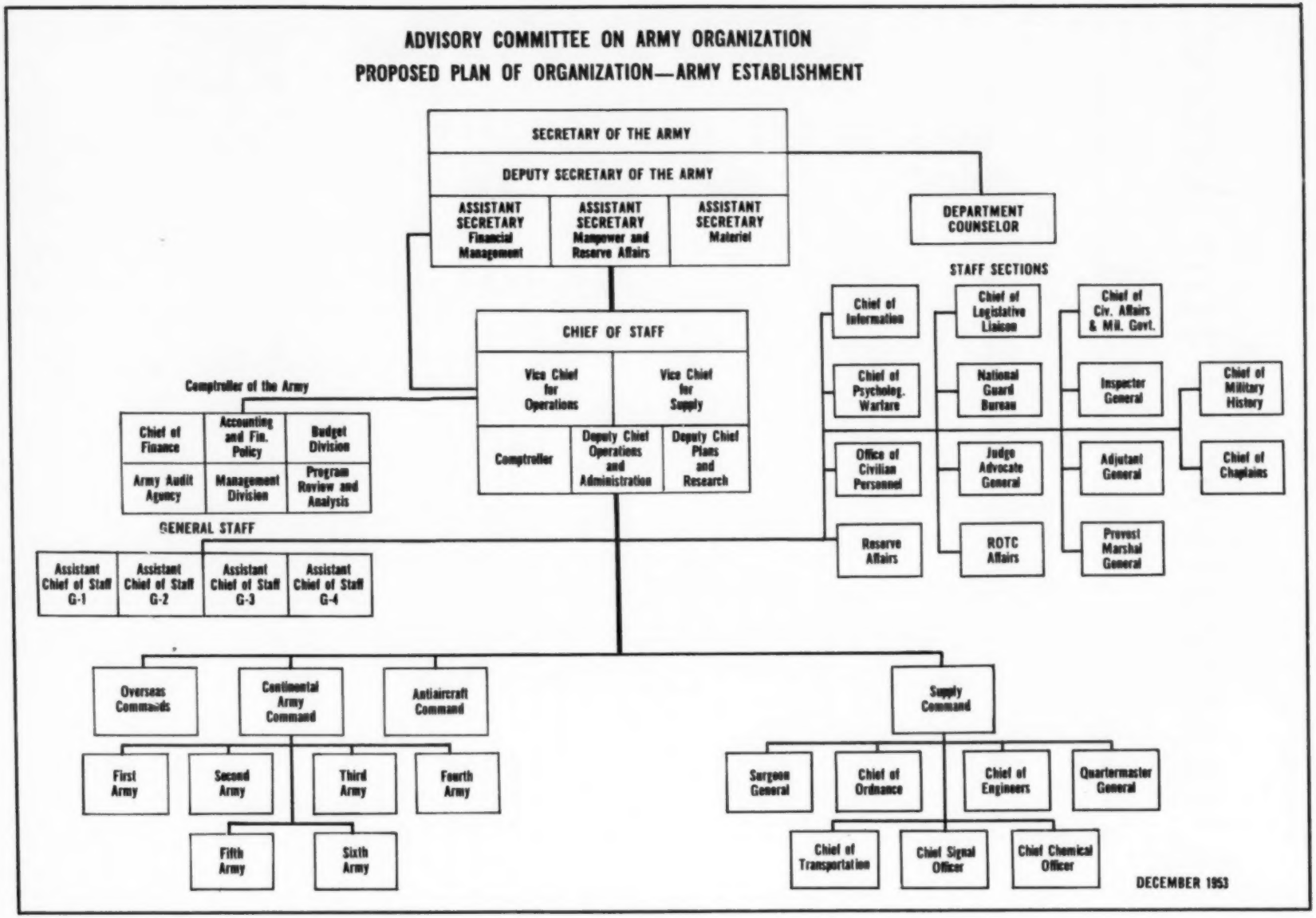
5. Existing budget, accounting, and reporting processes must be improved to make available at all times to the Secretary and his civilian assistants more revealing fiscal and operating data.

FUNDAMENTAL to any clarification of the Army's organization is the redefinition of the rôle of the Chief of Staff. We recommend that the Chief of Staff be recognized as the operating manager of the Army Establishment

The members of the Advisory Committee on Army Organization were: Paul L. Davies, president of the Food Machinery and Chemical Corporation, San Jose, Calif., committee chairman; C. Jared Ingersoll, chairman of the board of the Kansas, Oklahoma & Gulf Railway Company, Philadelphia, Pa.; Irving A. Duffy, vice-president in charge of purchasing, Ford Motor Company, Dearborn, Mich.; Harold Boeschenstein, president of Owens-Corning Fiberglas Corporation, Toledo, Ohio; and Lieut. Gen. Lyman L. Lemnitzer, Deputy Chief of Staff for Plans and Research, Department of the Army.

Mr. Ingersoll is a director of the American Ordnance Association and was chief of the Philadelphia Ordnance District during the Second World War. Mr. Duffy is a member of the Association's Council and served as head of the Legal Division, Office of the Chief of Ordnance of the Army, during the war.

Editorial comment on the Committee Report is published on page 779 of this issue of ORDNANCE.


ADVISORY COMMITTEE ON ARMY ORGANIZATION
PROPOSED PLAN OF ORGANIZATION—ARMY ESTABLISHMENT
SECRETARY OF THE ARMY
DEPUTY SECRETARY OF THE ARMY
ASSISTANT SECRETARY Financial Management
ASSISTANT SECRETARY Manpower and Reserve Affairs
ASSISTANT SECRETARY Materiel
DEPARTMENT COUNSELOR
STAFF SECTIONS
Chief of Information
Chief of Legislative Liaison
Chief of Civ. Affairs & Mil. Govt.
Chief of Psycholog. Warfare
National Guard Bureau
Inspector General
Chief of Military History
Office of Civilian Personnel
Judge Advocate General
Adjutant General
Chief of Chaplains
Reserve Affairs
ROTC Affairs
Provost Marshal General
CHIEF OF STAFF
Vice Chief for Operations
Vice Chief for Supply
Comptroller
Deputy Chief Operations and Administration
Deputy Chief Plans and Research
Comptroller of the Army
Chief of Finance
Accounting and Fin. Policy
Budget Division
Army Audit Agency
Management Division
Program Review and Analysis
GENERAL STAFF
Assistant Chief of Staff G-1
Assistant Chief of Staff G-2
Assistant Chief of Staff G-3
Assistant Chief of Staff G-4
Overseas Commands
Continental Army Command
Antiaircraft Command
First Army
Second Army
Third Army
Fourth Army
Fifth Army
Sixth Army
Supply Command
Surgeon General
Chief of Ordnance
Chief of Engineers
Quartermaster General
Chief of Transportation
Chief Signal Officer
Chief Chemical Officer
DECEMBER 1953

and held fully accountable to the Secretary for all department operations.

Improving Organization for Operations and Training.—To enable the Chief of Staff to serve effectively as the Secretary's operating manager, we recommend that the General Staff sections be divested of their major responsibilities for operating activities and that the following changes be made in the Staff Sections*:

1. The existing offices of Special Assistant for Civilian Component Affairs and the Executive for Reserve and R.O.T.C. Affairs be abolished and the latter supplanted by an Office of Reserve Affairs and an Office of R.O.T.C. Affairs.

The committee emphasizes the urgent need for aggressive consideration of the Army's program for building up and maintaining its Reserve forces.

2. The Office of Civilian Personnel be transferred from the Office of the Assistant Secretary for Manpower and Reserve Forces and be made responsible to the Secretary through the Chief of Staff.

3. Greater emphasis be placed upon civil affairs and military government in the Department of the Army and, to improve training in this field, that the Military Government Division of the Office of the Provost Marshal General and the Military Government Department of the Provost Marshal General School be transferred to the Office of Civil Affairs and Military Government.

4. The Judge Advocate General be made responsible for the supervision of legal staffs throughout the Army, including those assisting in procurement.

In addition, we recommend that:

The Office of Legislative Liaison be retained under the direction of the Chief of Staff;

The Office of Public Information be continued immediately responsible to the Chief of Staff;

The Office of Psychological Warfare be continued as a separate staff section;

The proposal to establish an Operations Division separate from G-3 be rejected;

The proposal that the offices of the Secretary and the Chief of Staff be combined in a single executive office be rejected;

The oft-repeated suggestion that the civil-works functions of the Corps of Engineers be assigned to another governmental department be rejected.

We also recommend that a Continental Army Command be created. This Command should assume all responsibilities of the Army Field Forces and should provide for more effective direction and evaluation of the performance of the six continental armies.

To establish a clearer line of accountability for training we recommend that:

1. All agencies with training responsibilities should be guided by general training policies developed by G-3.

2. The Continental Army Command should have sole responsibility for basic training of all individuals, all combat-arms training (individual and unit), all combined training, and for all civilian-component training for which the Department is responsible.

3. The Staff Sections and Supply Command should be responsible for the specialized training of individuals and units of the respective services until they are passed to armies in the field.

Improving Supply Management.—To establish a clearer line of accountability for supply activities of large and increasing importance we recommend:

Establishing the position of Vice Chief of Staff for Supply;

Establishing a Supply Command having general management responsibilities for the Technical Services;

Making the Supply Command fully responsible for the Field (Class II) installations of the Technical Services;

Establishing the rank of the Vice Chief of Staff for Supply, Commanding General Supply Command, Chief of Technical Services, and other personnel engaged in supply management at levels comparable to their counterparts in combat and operational activities;

Providing for vigorous career-management and training programs for supply personnel, including authorizing the Supply Command to establish personnel policies to meet its specialized needs.

Improving Organization for Research and Development.—Four steps are required to strengthen the Army's organization for research and development. We recommend:

1. Redefining and strengthening the authority assigned to the Chief of Research and Development in the Office of the Deputy Chief of Staff for Plans and Research.

2. Transferring to the Chief of Research and Development those planning functions now assigned to the Deputy Assistant Chief of Staff G-4 for Research and Development.

3. Transferring other functions assigned to the Deputy Assistant Chief of Staff G-4 for Research and Development to the Commander of the Supply Command.

4. Expanding the scope of the Secretary's Scientific Advisory Panel and otherwise promoting the interest and support of civilian scientists in the Army's research and development activities.

Improving Financial Management.—To improve the Army's financial management we have proposed the establishment of the position of Assistant Secretary for Financial Management. In addition, we recommend that:

The Office, Chief of Finance be placed under the direction of the Comptroller and its functions integrated with those of the Comptroller and that essential improvements be instituted:

1. In the Army's Primary Program System—so that it be made to conform with the revised organization that is adopted and be extended substantially.

2. In the Army's "performance budget"—the better to relate costs to work to be done and to adapt methods of allotment to organizational lines.

3. In the Army's accounting and reporting methods—specifically, the numerous existing accounting systems should be integrated or replaced by a single universal system of accounts, and existing reports should be reappraised in terms of the needs of the Secretary and his principal civilian or military assistants.

*The term "Staff Sections" is used throughout this report to refer to all staff organizations other than the General Staff sections and the Technical Staffs and Services.

Improving Career Management.—Finally, we recommend that concrete steps be taken to develop greater career opportunities within the Army for individuals specializing in the fields of supply management, research and development, and financial management.

* * *

The Secretary of the Army has authority to adopt most of the changes proposed. Two actions will require approval of the President and Congress:

1. To create a third Assistant Secretary—Financial Management—necessitates revision of the Army Organization Act of 1950, Title I, Section 102 and revision of General Order No. 23, March 2, 1953.

2. To establish a new position of Vice Chief of Staff (Supply) requires amendment of the Army Organization Act of 1950, Title IV, Section 102.

One action will require initiation by the Secretary of Defense. This is the reaffirmation that in instances where the Department is designated as "executive agent" the Secretary of the Army's continuing responsibility for the affairs of the Department is uninterrupted by communications from the Secretary of Defense to the Chief of Staff. In emergency situations when the Chief of Staff is authorized to receive and transmit such communications, it must be made clear that he acts for, and remains wholly accountable to, the Secretary of the Army.

Whatever other actions may be necessary to make the foregoing recommendations effective the committee recommends be taken.

(The proposed plan of organization of the Army Establishment resulting from these recommendations is depicted in the chart on page 770.)

* * *

Following are some of the committee's recommendations for improving the Organization of Supply Management.

In the event of another war, there is little likelihood that the Army would have the chance to reorganize and develop its supply organization *after* the start of hostilities. The possibility of slow-paced conversion and a long build-up, which characterized the early stages of World Wars I and II, disappeared in the smoke over Hiroshima on August 6, 1945.

(The term "supply" is used throughout the report to refer to that sequence of related activities that include research and development, computation of supply requirements, procurement, production, storage, distribution, maintenance, and disposal of matériel, the rendering of logistical services such as medical, communications, engineering, transportation, and the training of troops specializing in these activities and services.)

Victory—as well as the conservation of lives—depends in large measure on superiority in weapons and equipment at the moment war is thrust upon us. That superiority becomes progressively more important as weapons are made increasingly destructive and warfare depends more and more on highly specialized equipment.

To a great extent, superiority also will depend on the immediate efficiency

of the long supply lines demanded by the global character of the defense problems we and our allies face. The supply requirements consumed, even in 1953, a significant proportion of the country's total resources. In another war these requirements would absorb quantities of manpower and resources to an extent that would levy severe strain on the country's economy.

The Army's supply organization and its management must be equal now to achieving superiority and must be able to expand immediately to meet the requirements of an extreme emergency. These needs pose four specific questions:

1. Does the present organization provide for purposeful top-level planning and direction of the Army's supply and is it in position to gage the consequent impact on the Nation's economic and industrial resources?

2. Can the present organization direct and control those agencies of the Army responsible for the tremendous supply job that war would bring? Specifically, could the Assistant Chief of Staff, G-4, be expected, in addition to his other important duties, to be responsible for the effective general management of the Technical Services? If not, what kind of organization and what authorities would be required?

3. Should those agencies of the Army (the Technical Services) that produce, procure, develop, and distribute essential weapons, matériel, and equipment be organized as at present by type of item supplied or service rendered or is there need for change?

4. Does the Army offer adequate opportunities and incentives to provide the requisite competence in supply management? Does the Army's supply organization attract, develop, and hold an adequate number of qualified men, both military and civilian?

(The Technical Services are: The Medical Corps, Ordnance Corps, Corps of Engineers, the Quartermaster Corps, Transportation Corps, Signal Corps, Chemical Corps. In November 1953 these Technical Services contained more than 310,000 military and civilian personnel. Together they were responsible for the bulk of all procurement, research and development, production, distribution, and related services required by the Army.)

Effective management of the Army's supply activities—the development, production, procurement, storage, and distribution of weapons, matériel, and equipment—necessitates a high and specialized order of competence. It also requires the understanding and attention of the Army's top civilian and military leaders that its importance and magnitude dictate.

Civilian or Military Direction of Supply.—The committee considered carefully the desirability of having the Army's supply organization (specifically the Technical Services) report (either directly or through a military commander) to the civilian Assistant Secretary for Matériel rather than to the Chief of Staff.

We have concluded, however, after extended consideration, that the Chief of Staff should serve as the operating manager of the Department of the Army and be responsible to the Secretary for supply management as for all other operations.

Three factors of especial pertinence in the area of supply management reenforce our conclusion as to the responsibility of the Chief of Staff in that area —and make impracticable the assignment of that responsibility to a civilian Assistant Secretary:

1. Operational success and efficient and economical supply management require close coördination and the resolution of differences between the using and supply elements of the Army. For example, the development of new items of matériel requires the balancing of the users' desires with procurement feasibility and cost.

The Army's military planning—especially during periods of actual warfare —demands the closest coördination of operations and supply. Operational plans are often limited by the availability of supplies and by the Nation's productive capacities. Certainly, operational success is dependent on meeting planned supply requirements.

Military striking power is the combined product of well-trained and well-led forces and the best of matériel—in quantity and quality—that this country's industry can produce. This vital interdependence of supply and military planning makes it imperative that the Chief of Staff be responsible for supply and its coödination.

2. An additional factor is the difficulty that even the most highly qualified civilians coming in from the outside for relatively limited periods of time would have in acquiring sufficient background and well-established working relationships to be really effective in a line management capacity.

MOREOVER, it would be unwise to base a plan of organization on the assumption that individuals with the relevant business experience and administrative ability qualifying them to assume direct management responsibility for the Army's huge and complex supply job will be available.

Of the six men who have held responsibility for matériel functions as Under or Assistant Secretary since enactment of the National Security Act of 1947, only two had previous industrial experience pertinent to the Army's supply management activities.

"The Technical Services are established and experienced in their assigned jobs. They have met the needs of previous wars. The basic concept governing the organization of each, i.e., by type of item or service, has been confirmed by industrial experience."

3. The Army must be expected to develop effective organization and competent military personnel for both tasks (as other enterprises develop personnel equal to their needs), and the Chief of Staff must assume the responsibility for the efficiency of both operations.

The committee thus rejects the alternative of fixing responsibility for active direction and control of supply management in the Assistant Secretary for Matériel. The essential rôle of the impermanent civilian is to establish objectives, formulate policies, evaluate performance, and see that the military makes corrections and institutes improvements when they are required.

We believe that better results can be obtained by strengthening the Army's supply organization and by providing the civilian secretariat with a more effective means for establishing policies and evaluating performance rather than by superimposing in managerial capacity even the most highly qualified individuals coming from the outside with the probability of limited tenure. . .

EFFECTIVE management of the Technical Services requires, in the committee's opinion, the establishment of a Supply Command. To this Command the Committee recommends transfer of all authority now held by G-4 for direction and control of the Technical Services. G-4 would continue to serve as a section of the General Staff responsible for logistical planning. The Supply Command should be assigned full responsibility for direction and control of the Technical Services.

The scope and powers of the envisioned Supply Command would be far less sweeping than those granted the Army Service Forces of World War II. Various administrative services, such as The Adjutant General, the Provost Marshal General, and the Service Commands (the territorial predecessors of the present continental armies) should not be included. The Supply Command should not be granted any direct authority over overseas supply activities.

Creation of this Command is recommended to provide an authoritative commander of the Technical Services with effective control over all its available funds and personnel. The Supply Command should be assigned authority to prescribe the missions, organization, and procedures of the Technical Services.

Broadly speaking, however, the Committee envisions a "line and staff" type of organization similar to that of many industrial organizations. The Technical Services would represent the line or operating elements. In addition, the commander would require staff units to assist in formulating and communicating policy and to advise and assist the Technical Services.

These would likely include staffs specializing in research and development, computation of requirements, formulation of procurement policies, supply management, including stock control; storage, salvage, and disposal, etc. . . .

Creation of the Supply Command should result in significant savings from firm control and coördination of the technical activities. Any increase in manpower required at Command headquarters should be accomplished by the transfer of personnel (or spaces) from the Department of the Army staff, particularly from G-4, for the performance of the functions thus transferred. Other personnel may well be transferred from the headquarters of the Technical Services for the functions that thus become centralized.

The Technical Services are established and experienced in their assigned jobs. They have met the needs of previous wars. The basic concept governing the organization of each, *i.e.*, by type of item or service, has been confirmed by industrial experience. . . .

The immediate need is not for a major reorganization of the Technical Services; rather, it is to establish more effective general management and control of these services and to provide for their coördination.

Presidents of Local Posts of the

G. A. Gustafson
Aberdeen Post

A. V. Wiebel
Birmingham Post

Vice Adm. W. A. Kitts
Capital Cities Post

James R. Munro
Central Illinois Post

W. L. McCarter
Columbia River Post

Carl S. Hallauer
Empire Post

Col. Paul S. Bechtel
Florida Post

Stanley C. Hope
Hartford-Springfield Post

Harry Darby
Midwest Post

Frederick D. Hansen
Milwaukee Post

John L. McCague
Nebraska Post

George F. Hussey, Jr.
New York Post

P. S. Mumford
Quad Cities-Iowa Post

Col. Henry E. Minton
Rio Grande Post

James D. Maitland
Rocky Mountain Post

Walter Siegerist
St. Louis Post

Association

The Local Posts of the American Ordnance Association, located in thirty-five industrial, scientific, and educational centers throughout the United States, are a vital factor in the Association's task of fostering industrial preparedness.

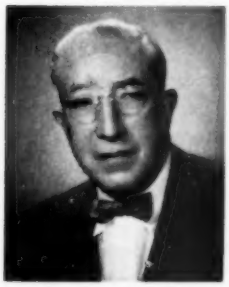
These Posts by their meetings, seminars, plant visits, and similar activities keep alive an interest in the continuing need for scientific and industrial know-how in the production of the weapons of defense. The presidents of these Posts, most of whom are shown below, are the key men in this nationwide effort for peace.

John Slezak
Chicago Post

Harold R. LeBlond
Cincinnati Post

Daniel W. Cronin
Citadel Post

Albert J. Weatherhead, Jr.
Cleveland Post



Robert C. Geffs
Los Angeles Post

Stanley A. Hoff
M. I. T. Post

C. L. Jacobson
Michigan Post

M. H. Johnson
Mid-Continent Post

W. C. MacFarlane, Sr.
Northwest Post

Albert W. Gilmer
Philadelphia Post

A. E. Walker
Pittsburgh Post

C. Walter Huffine
Puget Sound Post

G. M. Greenwood
San Francisco Post

W. O. Hedrick
Texas Post

Ludlow King
Washington Post

Helge Holst
Yankee Post

Month by Month: Highlights of the National Defense

Report On Production

The Senate and House of Representatives Joint Committee on Defense Production warned that "thin spots" in the Nation's industrial armor still posed a threat to defense production.

Difficulty and delays have been encountered in atomic-energy projects, strategic material stockpiling, and other key mobilization programs.

> *"Thin spots in our industrial armor," the Committee said, "would present problems of the utmost gravity under full mobilization."*

Although the Committee called attention to a delicate balance between supply and demand in a nation trying to provide both guns and butter, it expressed the view that the economy could "sustain military production at current peak levels with little strain on the economy or dislocation of civilian markets."

Partial mobilization aims have now been substantially achieved.

Senator Homer E. Capehart, chairman of the watchdog group, said the present defense build-up, in contrast with World War II, has been accomplished with small public fund expenditures.

"This result has been accomplished by relying upon Government loans and tax incentives to encourage and assist American free enterprise," he said. "Accelerated tax amortization has been granted for more than 18,000 new or expanded facilities costing $28,000,000,000. Approximately sixty per cent of the total cost was certified for accelerated tax amortization."

> *The Committee declared that completion of mobilization would require Government aid in various forms, including a continuance of quick tax write-offs for defense plants.*

The report called for a vigorous effort by defense planners and by American industry to overcome stockpiling shortages by seeking substitutes, stimulating private enterprise, and effecting conservation.

The number of stockpile items presenting difficult procurement problems has been cut, but the report indicated that there still were twenty-four items with stockpiles less than half full.

The stockpile program includes seventy-six materials. Goals have been reached for 23 of these, 9 others are more than 90 per cent complete, and an additional 20 are beyond the halfway point.

The report offered the following recommendations for bringing mobilization up to top-flight condition:

1. Realistic decisions on stockpile programs and the redesign of products needed for reserve.

2. Detailed information on which to base planning for the use of the Nation's resources.

3. Closer relation of military plans to feasible production levels.

"It is essential," the report concluded, "that the Joint Chiefs of Staff and the services have reasonably certain knowledge that their logistic and strategic plans are based on equipment flows that are neither far in excess of nor far below the Nation's ability to produce."

The Rocket Comes of Age

Does the Soviet Union have a rocket capable of crossing the Atlantic?

Recent Soviet hints are probably a mixture of reality and bluff, but they cannot be ignored in the face of past rapid Soviet achievement on atomic and hydrogen bombs.

This is the view of Dr. Wernher von Braun, former technical director of the German rocket experiment station at Peënemuende and now director of the United States Army Guided Missile Development Group at Redstone Arsenal, Huntsville, Ala.

> *In a* New York Times *interview, Dr. von Braun said that "the Russians have a sound guided missile program staffed by very able men."*

The first public evidence of intense Soviet interest in trans-Atlantic rockets was given in an article published in 1949 by a Soviet expert, Lieut. Col. G. A. Tokayev. He reported that at Stalin's personal order an all-out but unsuccessful effort had been made in 1947 to capture and bring to Russia two rocket scientists, Drs. Eugene Saenger and Irene Bredt, who had written a report showing mathematically how a rocket plane could cover long distances, such as a trans-Atlantic crossing.

The Seanger-Bredt report, prepared in Germany shortly before the Allied invasion of Europe in 1944, outlined a technique to enable a winged rocket to cover long distances and carry an atomic bomb.

The plan involved shooting a winged rocket into the upper atmosphere where the air would become too thin to support it. The rocket would then nose downward and enter the denser lower atmosphere at such a steep angle and with such speed that it would ricochet far upward again into too tenuous atmosphere.

> *The rocket theoretically would be able to cover thousands of miles horizontally while going through the series of ricochets.*

Dr. von Braun in the *Times* article stated that, after World War II, the Russians started production of V-2 rockets as soon as possible and then built their further developments from the relative narrow beginning made on that weapon.

The V-2 rocket, he indicated, was a logical starting point for the development of longer-range missiles such as would be required for bombardment of the United States from Europe.

Production and Unemployment

President Eisenhower will restudy the plan developed by the Office of Defense Mobilization to channel defense contracts to areas of unemployment.

The ODM policy prescribes "setasides" of from twenty to thirty per cent of defense contracts for firms in economically depressed communities that could meet the competitive low bids made by other companies.

> *Southern Congressmen strongly oppose the plan, fearing it would shift Government business from textile mills in their states to New England mills.*

New England members of Congress have said that their area is suffering a depression and not a recession.

The White House reaction was that, for obvious reasons, the bulk of defense contract orders would continue to be placed in communities now manufacturing such materials.

It is obvious that only a minor portion of defense contracting could be diverted to surplus-labor areas. Transportation costs, wage differentials, and proximity to raw materials would largely determine textile orders.

General Eisenhower said there has been some misunderstanding of the plan, adding that it is merely an attempt to help out areas of high unemployment by giving them work which is useful to the Nation.

> *The proposal, the President said, is to channel a defense contract to such an area only if the bid from a plant in that area is as low as any bid from outside the area.*

Somehow, he said, the idea has grown that contracts would simply be shoved somewhere that the Government wants them.

The discussion thus far has centered on textiles. However, Washington observers are in complete agreement that, in the field of weapons manufacture, the guiding principle must be not the relief of economic distress but the production of the best ordnance by the firms best qualified to produce it.

Quality, in weapons making, must be the primary consideration. Time should be secondary, cost next, and then relief of economic distress.

There is a world of difference between handkerchiefs and howitzers: A soldier in battle can survive with a second-rate handkerchief.

"Operation Pullback"

The Korean war is over. This is the assumption on which the American decision is based to withdraw two U. S. divisions and an increasing number of U. S. personnel in the future.

Present strategy in Asia is to disengage our troops from the mainland and to rely upon air, naval, and atomic power to discourage new aggressions.

> *The United States has six divisions in Korea. There is another Army division and the reënforced Third Marine Division in Japan.*

The American-trained South Korean Army numbers 600,000 men. When peak strength is reached, twenty divisions, aided by American troops and other United Nations troops remaining in Korea, should be able to hold the truce line if the enemy tries a new push south.

Withdrawal of the two U. S. divisions is intended to correct an awkward defense position. Today the bulk of America's combat troops are stationed in Asia at the end of a 10,000-mile supply line. Such a situation seriously handicaps our freedom of movement in case of emergency. The Joint Chiefs of Staff want a large percentage of our fighting force at home.

South Koreans have made rapid military progress. They have established their own supply lines, have set up sixteen specialized schools, and have their own military academy patterned on West Point.

Although 5,000 South Korean veterans are going out of service each month, approximately 100,000 Koreans reach military age each year. Seven hundred a day will continue to enter military service until the army is up to strength.

The cost to American taxpayers of maintaining the South Korean Army is more than a billion dollars a year. Savings will be realized, however, by withdrawing U. S. troops and by relying on a new Japanese force of 200,000 to defend that country.

The Chinese have seventeen of their own armies and seven North Korean corps—a combined strength of one million men. These forces have not been reduced. At the same time there is no evidence of any regrouping of forces to undertake an offensive.

> *Chinese air power has been expanded. Jets have been substituted for conventional planes and airfields have been repaired.*

Both sides seem to be on the defensive. President Eisenhower is therefore taking a calculated risk that the Korean war is really over.

Automatic Factories

The present trend in mass production is to substitute improved machines for manpower, looking toward an almost completely automatic factory. This is a development that will add greatly to America's defense potential.

In the new Ford auto-engine plant at Brookpark Village, Ohio, for example, it takes only three machines and nine men to drill the necessary oil holes in a crankshaft. With conventional machining methods, twenty-nine machines and thirty-nine men were needed to perform the same operation.

The auto-engine blocks are machined without human labor at all. An electronic brain, containing twenty-seven miles of wire, helps mastermind the job. Signal lights on control boards flash warnings when a tool is wearing out and needs replacement. Red, green, and yellow push buttons control myriad manufacturing steps.

> *The main attraction of new labor-saving devices is the possibility of production at lower cost per unit, largely through labor savings.*

At a Nash-Kelvinator plant, according to a survey made by the *Wall Street Journal*, one of its installations for machining engine cylinder heads reduces the man-hours required for this operation by eighty per cent. Previously the task required fifteen separate machines; now only one is used.

Much of the trend to greater automatic operation is aimed at shifting still further from men to machines the job of moving materials from one production operation to the next. According to one estimate, thirty to thirty-five per cent of every production dollar is normally spent for this handling of materials in the factory.

The new Westinghouse Electric plant in Columbus is scheduled to produce 4,000 major appliances a day, mostly refrigerators and freezers.

The components of these units will travel over twenty-seven miles of conveyors and through automatic enameling and assembling devices. The finished products will be whisked through an automatic crating machine, where boards, nails, and other materials will quickly box them for shipment.

> *Because of the long conveyor mileage and extra-efficient layout, materials handling and servicing at the Columbus plant will amount to only nine per cent of the retail price of a refrigerator.*

At the new mechanized General Electric plant outside Louisville, Ky., about one hundred acres of the plant site will be under one roof, with parts in process being shuttled over forty-two miles of conveyors.

One reason why greater automatic operation will not reduce prices in the immediate future is the big outlay being invested in its development. The initial cost will not be made up by slashing prices on automobiles and appliances.

National Defense Report

In his first semiannual report to President Eisenhower, dealing with the period from January 1 to June 30, 1953, Secretary of Defense Charles E. Wilson, declared that defense costs would remain high for many years to come.

> *The American people, Mr. Wilson said, would have to learn to accept military service for their sons as "a normal duty during the present period of international tension."*

By the middle of 1953, Mr. Wilson indicated, the Army, Navy, Air Force, and Marine Corps represented "the most powerful military force ever assembled short of war and constituted the major deterrent to further Communist aggression against the free world."

He pointed out that the major problem facing the country at this time was to find the point of balance between economy and strength; to provide sufficient military power to deter aggression without undermining the economic health of the United States.

Robert B. Anderson, Secretary of the Navy, said in the same report that the United States fleet, composed chiefly of ships built during World War II, was aging rapidly.

"The current shipbuilding program is much smaller than required to sustain the fleet of present magnitude," Mr. Anderson said. "The average age of a naval vessel varies from five to twenty years, depending on the type.

"This means that the smaller craft already have far outlived their normal life span, and even the larger ships are approximately at the half-way mark."

> *Harold E. Talbott, Secretary of the Air Force, reported that plans to train 10,000 pilots in fiscal year 1953 and 12,000 men in each of the succeeding years had been scaled down to 7,200 men each year.*

Robert T. Stevens, Secretary of the Army, said that his service was finding it increasingly difficult to attract and hold career soldiers. He warned that this situation could have grave consequences and that remedial action was vitally necessary.

The Production Picture

A recent report compiled by the Office of the Assistant Secretary of Defense for Supply and Logistics revealed that 61.2 per cent of the production of defense equipment was credited to the 100 top-ranking companies at the end of June 1951. By the following year the percentage had risen to 62.4 per cent, and a year later to 64 per cent.

The report did not give the exact count of the thousands of smaller concerns which, as subcontractors and subsubcontractors, furnished the raw materials and parts for these major assemblies.

But the Assistant Secretary's office stressed a most important phase of the problem when it emphasized that prime contractors for aircraft, tanks, weapons, electronics, and other complex equipment or specialized types of military supplies are of necessity selected on the basis of their ability to manufacture and assemble the matériel in quantities and on schedules required by the armed forces.

Research Is War Deterrent

Dr. Mervin J. Kelly told the annual meeting of the American Association for the Advancement of Science in Boston that the arsenal of democracy, now being created as the result of research in America's laboratories, has grown so powerful that it should deter a prospective enemy from war.

The various research laboratories of the country—Government, academic, philanthropic, and industrial—are making America "the arsenal of the free world and the leader in its struggle to maintain its security," said Dr. Kelly, who is president of the Bell Telephone Laboratories and one of the Nation's leaders in industrial research.

> *The Nation is now spending $3,600,000,000 a year on basic and applied research, he reported. Of this sum, some $2,400,000,000 is financed by the Government and $1,200,000,000 by industry and private citizens.*

About $2,200,000,000, or 60 per cent, is devoted primarily to the military and $1,400,000,000 to the civilian economy.

Industrial laboratories, he added, are doing about 65 per cent—some $2,400,000,000—of the Nation's basic and applied research, with $1,300,000,000 being financed by the Government for military needs and $1,100,000,000 by industry for civilian needs.

While these astronomical dollar-volume figures are impressive, Dr. Kelly said, the contributions to military strength and to the civilian economy this money produces are even more impressive.

During World War II, he declared, research revolutionized warfare with such developments as radar, sonar, proximity fuzes, acoustically homing torpedoes, and atomic bombs. But since the end of the war, he continued, new developments have been made at a great pace.

The combined effectiveness of new weapons, he said, is appalling and, as a result, military manpower actually can be reduced with no sacrifice in military strength.

First Things First in the Army

An Editorial

ON August 24, 1953, Secretary of the Army Robert T. Stevens appointed a distinguished 5-man committee to review the Army's existing organizational structure and to advise on "ways and means of strengthening the organization to meet the national-security mission assigned to the Army."

On January 14, 1954, Mr. Stevens released the Report of the Advisory Committee on Army Organization, stating that he was certain that the study will prove most valuable "in helping to increase the efficiency and effectiveness of the Army and in our earnest and continuing endeavors to effect every reasonable economy in defense without endangering the security of our Nation." A summary of the recommendations of the committee is published on page 769 of this issue.

The report is indeed very valuable for two basic reasons—the high competence of the businessmen who drafted it and the shrewd, realistic, time-tested philosophy of business management that they fearlessly championed.

The committee consisted of four industrial leaders of diversified backgrounds from different sections of the country and a general officer with more than thirty years of service. The Nation owes a great debt of gratitude to the following patriotic citizens:

Paul L. Davies, president of the Food Machinery and Chemical Corporation, San Jose, Calif., committee chairman; C. Jared Ingersoll, chairman of the board of the Kansas, Oklahoma & Gulf Railway Company, Philadelphia, Pa.; Irving A. Duffy, vice-president in charge of purchasing, Ford Motor Company, Dearborn, Mich.; Harold Boeschenstein, president of Owens-Corning Fiberglas Corporation, Toledo, Ohio; and Lieut. Gen. Lyman L. Lemnitzer, Deputy Chief of Staff for Plans and Research, Department of the Army.

The committee met regularly in executive session over a 3-month period, held hearings on 28 days, listened to and questioned 129 witnesses, and examined more than 50 pertinent books, documents, and studies before preparing the report.

The Department of the Army thought so well of the report that it awarded the Army's Certificate of Appreciation, the highest award that can be made to persons not employed by the Army, to the four civilian members of the committee.

THE business-management philosophy of the Davies Committee is worthy of the utmost consideration.

It is a truism that equal importance attaches to the people who *do* things and to the people who plan things. Both have important and necessary functions.

An unplanned and uncoördinated operation usually invites failure—and no amount of individual zeal can save it. At the same time, a well-planned operation will fail because of clumsy, inexperienced and inept implementation—and no amount of additional scheduling can rescue it.

Experienced planning and decisive action are the twin ingredients of success in any field—in the Army no less than in industry. But failure inevitably occurs under one other condition—if the planners obstruct and get in the way of the doers. Thus it has been up till now in the Department of the Army.

The industrial and military history of our day is replete with examples that the surest guarantee of success is to select a capable leader and then give him every possible support and assistance that will enable him to carry out successfully the task assigned him. This philosophy has long been standard operating procedure in American industry, and it still applies, with equal force, to the supply services of the Department of the Army.

THE Davies Report is an outstanding accomplishment. It clearly draws the line of authority and responsibility from top to bottom in the Department of the Army.

It clearly defines the management arrangements of staff supervision and administrative operational control.

It clearly and definitely indicates the importance of logistics in modern warfare. However, in recommending a "Supply Command," the report sharply defines and limits its authority with regard to the functioning of the Supply Services. It emphatically is against the revival of the Army Service Forces organization of World War II.

The Davies Committee placed special emphasis on its conclusion that the civilian Secretary of the Army has complete responsibility for all Army operations.

The committee also stressed the need for establishing clear-cut lines of authority and responsibility within the Army and the importance of providing new means to insure sound financial management.

Specifically, the committee recommended that the rôle of the Chief of Staff be redefined in accordance with this concept. It is proposed in the report that he be recognized as the Army's "operating manager," fully accountable to the Secretary for all operations of the Department.

The creation of a Supply Command was recognized by the committee as a means of establishing full accountability.

By giving additional freedom from hampering military controls to the supply services, by emphasizing civilian control, and by calling for greater decentralization, the committee is properly seeking greater efficiency and economy in Army logistics.

The committee's constructive recommendations are simply a plea to put first things first in our Army and in so doing to have the planners plan and the operators operate with the former definitely not hamstringing the latter!

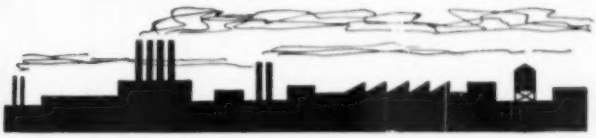
Bridge-laying Tanks

The new 43-foot wheeled assault bridge in the foreground above can support 60 tons and can be pushed quickly across a gap by a tank, even under fire. At right, above, is shown an experimental aluminum scissors-type bridge in folded position on a modified turretless tank while below the bridge is shown being unfurled and launched by the vehicle (Army photographs).

Reg. U. S. Pat. Off.

INDUSTRIAL PREPAREDNESS

a monthly report on current scientific and logistical developments as they relate to the national defense



This bulletin appears regularly in ORDNANCE. In the months in which the magazine is not published this bulletin is mailed directly to the members of the Technical Divisions and Committees of the Association

No. 89 March 1954

● **The Annual Meeting of the Dimensional Standards and Metrology Division** of the A.O.A. was held at the Air Armament Test Center, Eglin Air Force Base, Fla., on January 7 and 8, 1954, with 70 persons attending. Brig. Gen. Edward P. Mechling, Commander, Air Armament Test Center, was the official host and extended a cordial personal welcome to the group as well as the greetings of Maj. Gen. Patrick W. Timberlake, Commander of the Air Proving Ground Command, who was absent from the base at the time.

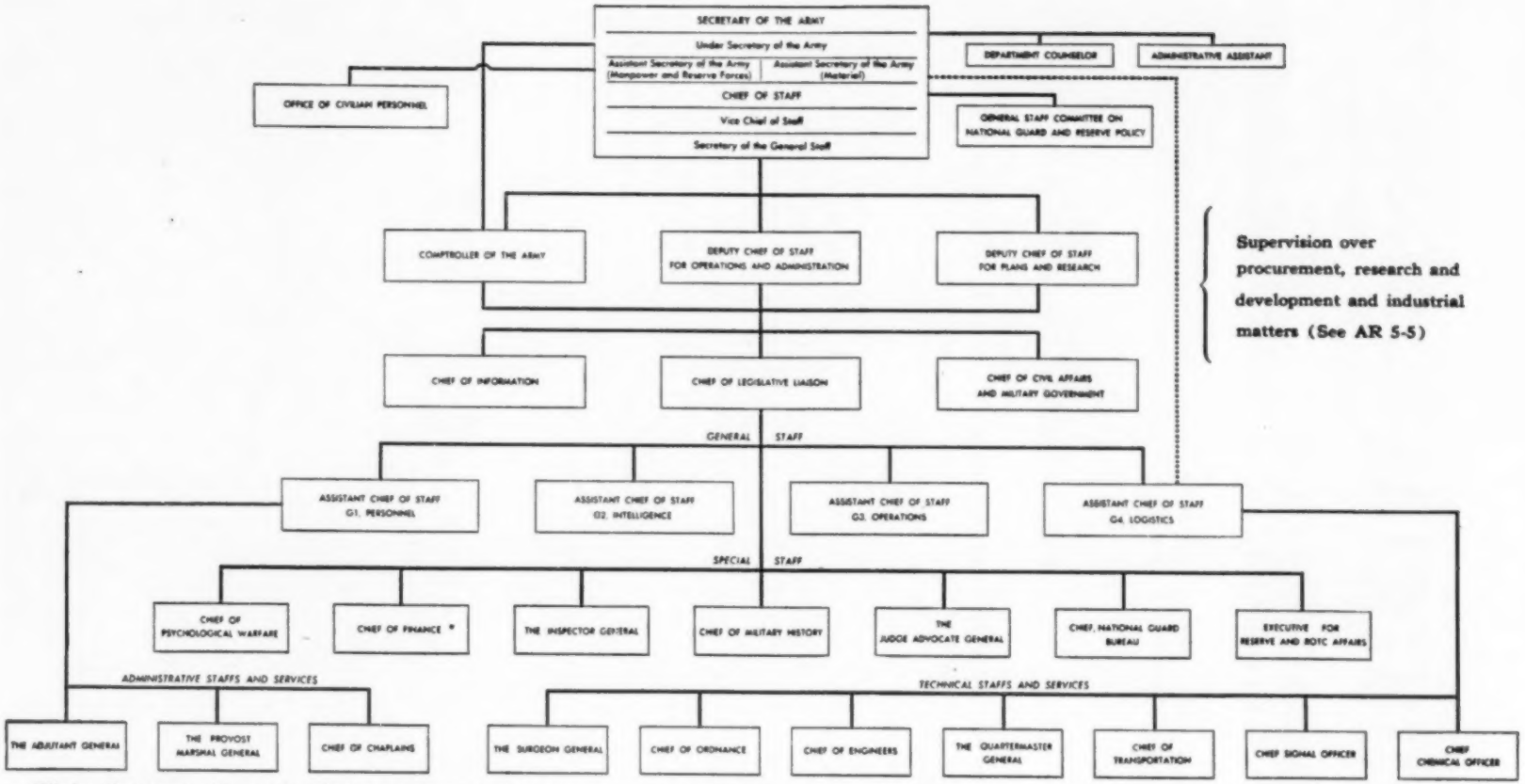
On the evening of January 7th the members of the Division and their guests were honored to join with the members of the Florida Post of the A.O.A. at their Annual Dinner Meeting. General Mechling presided as an entertaining and enthusiastic toastmaster with Dean Joseph Weil, College of Engineering, University of Florida—a long-time good friend of Ordnance—as the principal speaker.

The following day a series of technical sessions was conducted by Louis Polk, chairman of the Division. In the discussions developed and in the excellent papers presented at this meeting great emphasis was devoted to the technical aspects of the problems under consideration. This added greatly to the worthwhile nature of the meeting and was the subject of much favorable comment.

Concluding the afternoon session, the group was afforded a most informative briefing and demonstration outlining the organization, equipment, and operations of the Air Armament Test Center by Col. Richard E. Sims, chief of the Armament Test Facili-

Members and guests who attended the annual meeting of the A.O.A. Dimensional Standards and Metrology Division.

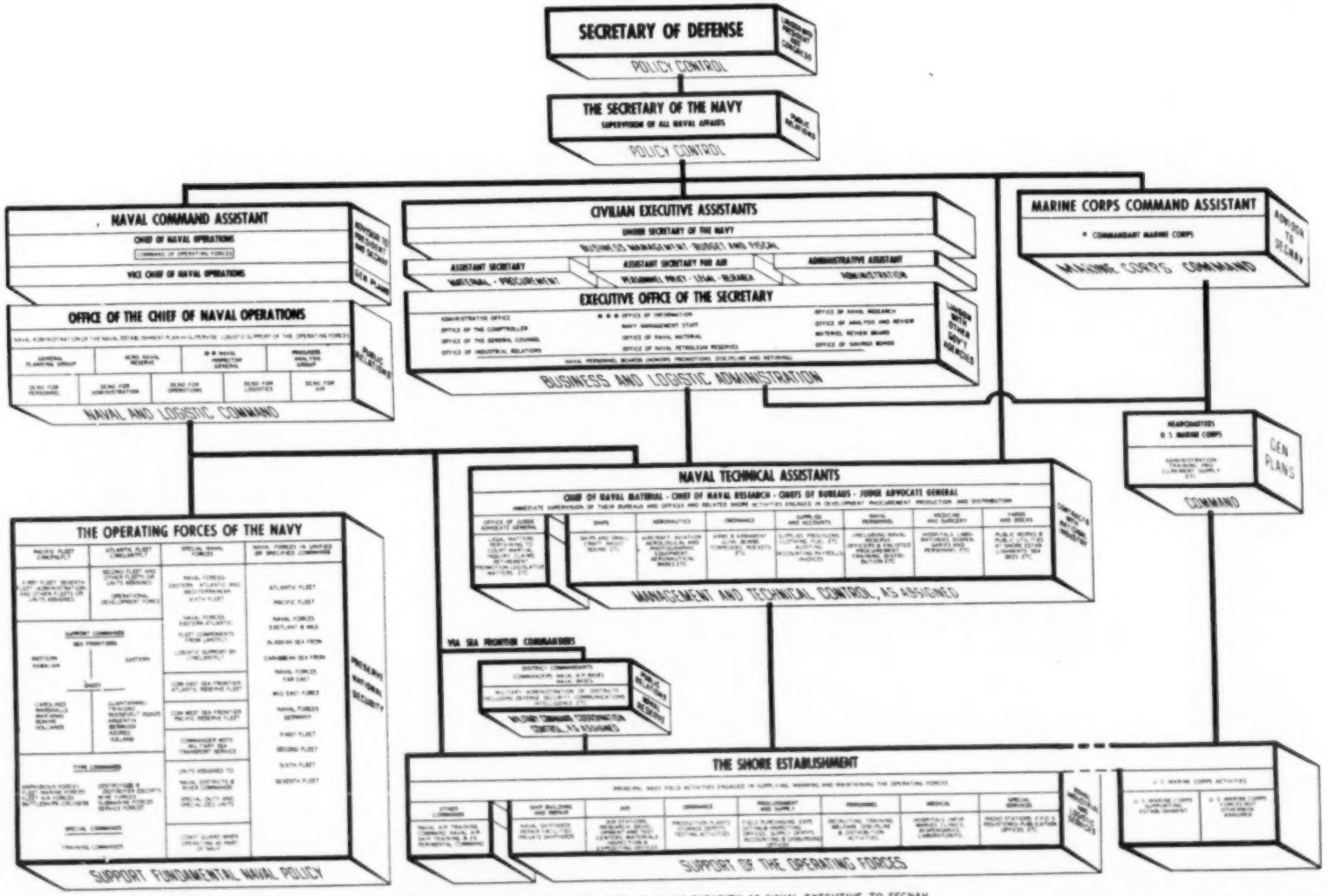
ORGANIZATION OF THE DEPARTMENT OF THE ARMY


SECRETARY OF THE ARMY
Under Secretary of the Army
Assistant Secretary of the Army (Manpower and Reserve Forces)
Assistant Secretary of the Army (Material)
CHIEF OF STAFF
Vice Chief of Staff
Secretary of the General Staff
DEPARTMENT COUNSELOR
ADMINISTRATIVE ASSISTANT
OFFICE OF CIVILIAN PERSONNEL
GENERAL STAFF COMMITTEE ON NATIONAL GUARD AND RESERVE POLICY
COMPTROLLER OF THE ARMY
DEPUTY CHIEF OF STAFF FOR OPERATIONS AND ADMINISTRATION
DEPUTY CHIEF OF STAFF FOR PLANS AND RESEARCH
Supervision over procurement, research and development and industrial matters (See AR 5-5)
CHIEF OF INFORMATION
CHIEF OF LEGISLATIVE LIAISON
CHIEF OF CIVIL AFFAIRS AND MILITARY GOVERNMENT
GENERAL STAFF
ASSISTANT CHIEF OF STAFF G1, PERSONNEL
ASSISTANT CHIEF OF STAFF G2, INTELLIGENCE
ASSISTANT CHIEF OF STAFF G3, OPERATIONS
ASSISTANT CHIEF OF STAFF G4, LOGISTICS
SPECIAL STAFF
CHIEF OF PSYCHOLOGICAL WARFARE
CHIEF OF FINANCE *
THE INSPECTOR GENERAL
CHIEF OF MILITARY HISTORY
THE JUDGE ADVOCATE GENERAL
CHIEF, NATIONAL GUARD BUREAU
EXECUTIVE FOR RESERVE AND ROTC AFFAIRS
ADMINISTRATIVE STAFFS AND SERVICES
TECHNICAL STAFFS AND SERVICES
THE ADJUTANT GENERAL
THE PROVOST MARSHAL GENERAL
CHIEF OF CHAPLAINS
THE SURGEON GENERAL
CHIEF OF ORDNANCE
CHIEF OF ENGINEERS
THE QUARTERMASTER GENERAL
CHIEF OF TRANSPORTATION
CHIEF SIGNAL OFFICER
CHIEF CHEMICAL OFFICER

*Under direct supervision and control of the Comptroller of the Army on Comptroller statutory functions

Organization as of July 1, 1953

ORGANIZATION OF THE DEPARTMENT OF THE NAVY


SECRETARY OF DEFENSE
POLICY CONTROL
THE SECRETARY OF THE NAVY
POLICY CONTROL
NAVAL COMMAND ASSISTANT
CHIEF OF NAVAL OPERATIONS
VICE CHIEF OF NAVAL OPERATIONS
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
NAVAL AND LOGISTIC COMMAND
CIVILIAN EXECUTIVE ASSISTANTS
UNDER SECRETARY OF THE NAVY
ASSISTANT SECRETARY
ASSISTANT SECRETARY FOR AIR
ADMINISTRATIVE ASSISTANT
EXECUTIVE OFFICE OF THE SECRETARY
BUSINESS AND LOGISTIC ADMINISTRATION
MARINE CORPS COMMAND ASSISTANT
COMMANDANT MARINE CORPS
MARINE CORPS COMMAND
HEADQUARTERS U.S. MARINE CORPS
COMMAND
NAVAL TECHNICAL ASSISTANTS
CHIEF OF NAVAL MATERIAL - CHIEF OF NAVAL RESEARCH - CHIEFS OF BUREAUS - JUDGE ADVOCATE GENERAL
MANAGEMENT AND TECHNICAL CONTROL, AS ASSIGNED
THE OPERATING FORCES OF THE NAVY
SUPPORT FUNDAMENTAL NAVAL POLICY
VIA SEA FRONTIER COMMANDERS
THE SHORE ESTABLISHMENT
SUPPORT OF THE OPERATING FORCES

* RESPONSIBLE TO CNO WHEN CNO IS ACTING IN HIS CAPACITY AS NAVAL EXECUTIVE TO SECNAV
** COLLATERAL RESPONSIBILITIES TO SECNAV
*** DUAL RESPONSIBILITIES TO SECNAV AND CNO

ORGANIZATION AS OF AUGUST 1, 1953

ties Laboratory, Air Force Armament Center, and Col. Paul S. Bechtel, deputy chief of Staff for test operations at the center.

● **On pages 2 and 3 of this issue** of INDUSTRIAL PREPAREDNESS are shown the organization charts of the U.S. Army and Navy as they existed in the latter part of the year 1953. At that time the Secretaries of the Army and of the Navy each appointed a committee to make detailed organization studies of their respective Departments and to report such changes as might be desirable under current conditions. A summary of the recommendations of the Army committee and a chart showing the proposed reorganization are published on pages 769-773 of this issue.

The Army Committee consisted of: Harold Boeschenstein, president, Owens-Corning Fiberglas Corporation, Toledo, Ohio, chairman; Paul L. Davies, president, Food Machinery & Chemical Corporation, San Jose, Calif.; Irving A. Duffy, vice-president, Ford Motor Company, Detroit, Mich., and a member of Council, A.O.A.; C. Jared Ingersoll, chairman of the board of the Kansas, Oklahoma & Gulf Railway Company, Philadelphia, Pa., and a director of the A.O.A.; and Lieut. Gen. Lyman L. Lemnitzer, Deputy Chief of Staff for Plans and Research, Department of the Army.

The Navy Committee consisted of Under Secretary of the Navy Thomas S. Gates, Jr., chairman; Adm. Donald B. Duncan, Vice Chief of Naval Operations; Lieut. Gen. Gerald C. Thomas, Assistant Commandant and Chief of Staff of the Marine Corps; Vice Adm. John E. Gingrich, Chief of Naval Material; Rear Adm. Ruthven E. Libby, Assistant Chief of Naval Operations for Operations; Vice Adm. Earl Mills, U.S.N., Ret.; Hobart Ramsey; and Richard Paget. Rear Adm. Ira H. Nunn, Judge Advocate General of the Navy, was counsel to the committee.

● **Production equipment** controlled by the Department of Defense will be reserved for defense production except in cases of extreme emergency approved upon recommendation of the military departments, C. S. Thomas, Assistant Secretary of Defense (Supply and Logistics), said recently.

A Defense Department directive to assure the continuing availability of production equipment for mobilization was issued and is effective immediately. It extends the policy guidance set forth in Defense Mobilization Order VII-4 of October 9, 1953, and applies to the types of equipment listed in Supplement A, Defense Mobilization Order 18 of May 30, 1952.

Emergency requests for nondefense use of Defense-controlled production equipment will be submitted by the military departments through normal channels to the Assistant Secretary (Supply and Logistics) for evaluation before submission to the Office of Defense Mobilization for approval.

Nondefense production is defined as all production which does not result in military end items or components intended to be incorporated physically into such end items. In cases where production equipment is to be used to produce both defense and nondefense items, production will be considered as nondefense when less than 75 per cent of the output is for military end items or components.

Requests by the military departments for approval to permit nondefense use of Defense-owned equipment must contain a complete justification "indicating the advantage to mobilization readiness and national defense which would result from the requested approval."

The requests will be submitted through normal channels to the Assistant Secretary (Supply and Logistics) for evaluation and forwarding to the Office of Defense Mobilization.

● **A coördinated program** for the disposal of excess military stocks has been ordered by Defense Secretary Charles E. Wilson.

Various projects for weeding out surplus matériel currently being carried out by various military departments will be placed under one program supervised by C. S. Thomas, Assistant Secretary of Defense (Supply and Logistics).

Mr. Thomas, who will work out the details of the program with the coöperation of the procurement Secretaries of the military departments, asserted that the clogging of military supply systems with unserviceable, obsolete, and surplus items was "indefensible."

He pointed out that all items determined surplus to U.S. and allied needs will be eliminated to make the military supply system "more flexible and responsive to the demands of military operations."

Particular emphasis, he said, would be placed on the cross-servicing area of "interdepartmental storage." Cross servicing refers to the storage and issue by one military department of stocks belonging to another department.

"It is imperative that the military departments determine their requirements and then relate stocks physically held in storage at depots, bases, posts, camps, and stations against those requirements and determine what should be procured, retained, or disposed of," he said.

Elimination of surplus matériel will conserve storage space and thereby reduce carrying charges.

ASSOCIATION AFFAIRS

K. T. Keller, A.O.A. Stalwart, Honored as Former Director of Guided Missiles

K. T. Keller, chairman of the board of Chrysler Corporation and a director of the American Ordnance Association, was honored by the United States Air Force for his exceptional service as Director of Guided Missiles.

At a ceremony on January 11th, in the Pentagon, Washington, D. C., Mr. Keller was praised by Air Force Secretary Harold E. Talbott for his contributions during both World Wars and in the Korean conflict. In the citation which accompanied the award his work was described as having advanced guided missiles "from drawing board to military reality."

Mr. Keller was Director of Guided Missiles on the staff of the Secretary of Defense from October 1950 to September 1953.

He was the recipient of the Levin H. Campbell Gold Medal of the American Ordnance Association for his leadership in the design and production of combat vehicles during the Second World War and was similarly honored by the Association's Cincinnati Post with the Charles L. Harrison Gold Medal.

He is a life member of the Association and is a most helpful member of its board of directors where his counsel and advice have been of inestimable value.

Gen. Charles L. Bolte, Vice Chief of Staff, Addresses the Michigan Post

The Michigan Post winter dinner meeting on January 27th brought out a crowd of 600 members to greet Gen. Charles L. Bolte, Vice Chief of Staff of the Army, the guest of honor.

Henry T. Bodman, president of the Michigan Post, called the meeting to order and introduced the newly elected officers who will assume their duties shortly. The next Post president is Charles L. Jacobsen, Chrysler Corporation. The vice-presidents are James K. Fulks, Ex-Cell-O Corporation, and Britton L. Gordon, Blackmer Pump Company, who is also a member of the National Council and a director of the Western Michigan Chapter.

Charles W. Brownell will continue in the office of secretary-treasurer which he has handled so capably for many years.

The many distinguished citizens of Michigan and guests at the speakers' table included most of the Post's directors, the newly elected officers and the following:

Del S. Harder, Ford Motor Company; Maj. Gen. R. A. Grussendorf, commanding general, Tenth Air Force; Brig. Gen. S. L. A. Marshall, *The Detroit News;* Col. Edward D. Mohlere, deputy chief, Detroit Ordnance District; Col. James B. Colson, chief, Michigan Military District; Col. Harold Parsons, commanding officer, Detroit Arsenal; James V. Votta, Aero Club of Michigan; Brig. Gen. Gerson K. Heiss, commanding general, Ordnance Tank-Automotive Center; Robert L. Biggers, Chrysler Corporation; Capt. Marshall T. Martin, U.S.N., commanding officer, Naval Air Station, Grosse Ile; Col. G. C. Carlson, chief, Field Service, Ordnance Tank-Automotive Center; and Capt. W. T. Hart, Jr., U.S.N., inspector, Navy Matériel.

Mr. Bodman introduced the toastmaster, Sherrod E. Skinner, vice-president, General Motors Corporation, whose most recent amazing exploit was to get the hydramatic transmission production line back into operation eighty-four days after the disastrous fire last fall. Mr. Skinner presented General Bolte to the audience with a well-phrased account of the general's distinguished Army career of forty years both in the field and on the General Staff.

The rôle of the General Staff was reviewed by General Bolte who compared it to the top officer organization in the industrial corporations of the United States and stressed its essential planning function in the Army. He told how plans of the General Staff generate Army requirements that filter down to Ordnance as procurement orders. He also paid tribute to the American Ordnance Association.

• **GEN. CURTIS E. LeMAY**, Commanding General of the Strategic Air Command, was the honor guest and principal speaker at the annual meeting of the Pittsburgh Post which was held December 7, 1953, in the ballroom of the Hotel William Penn, Pittsburgh.

More than 700 members and guests were in attendance to honor General LeMay and to hear his address.

A. E. Walker, chairman of the board and president of the National Supply Company and also president of the Pittsburgh Post, presided at the dinner meeting. Thomas E. Millsop, president of Weirton Steel Company and vice-president of the Post, served as toastmaster.

Arrangements for the meeting were in the hands of a committee under the chairmanship of Col. Thomas H. Eddy, treasurer of the Post, and Maj. William S. Rial, Jr., Post secretary. A report on the activities of the American Ordnance Association was given by Col. Leo A. Codd, the Association's executive vice-president.

In addition to the above officers, the following directors of the Post, representatives of industry in the Pittsburgh area, were at the speakers' table: Robert C. Enos, president, Rockwell Spring and Axle Company; William K. Fitch, chairman of the board, Dravo Corporation; Kirkland C. Gardner, chairman of the board, United Engineering & Foundry Company; Lorenz Iversen, president, Mesta Machine Company; Adm. Ben Moreell, chairman of the board, Jones & Laughlin Steel Corporation; Gwilym A. Price, president, Westinghouse Electric Manufacturing Corporation; Gen. Brehon Somervell, chairman of the board and president of Koppers Company.

The following are also directors of the Post: John A. Appleton, vice-president, Central Division, Pennsylvania Railroad Company; Frank R. Denton, vice-chairman of the board, Mellon National Bank and Trust Company; Robert C. Downie, chairman of the board and president, Peoples First National Bank and Trust Company; Harry B. Higgins, president, Pittsburgh Plate Glass Company; Clifford F. Hood, president, United States Steel Company; George H. Love, president, Pittsburgh-Consolidation Coal Company; Sidney A. Swensrud, chairman of the board, Gulf Oil Corporation; and Irving W. Wilson, president, Aluminum Company of America.

Dean Witter, above, left, chats with B. C. Heacock and Col. John M. Stark before the luncheon held in his honor at the Fairmont Hotel, San Francisco.

Dean Witter Honored as Retiring Chief of the San Francisco Ordnance District

Dean Witter, a vice-president of the American Ordnance Association, has retired as Chief of the San Francisco Ordnance District.

The San Francisco financier was officially commended by Maj. Gen. E. L. Cummings, Chief of Army Ordnance, in a special message sent from Washington to the luncheon held in his honor at the Fairmont Hotel, San Francisco, on January 12th. Mr. Witter was commended for his active rôle in mobilizing industry in the Bay Area and the Pacific Northwest to meet Army requirements following the outbreak of the Korean situation.

During his more than three years as district chief, from October 1950 to January 1954, Ordnance contracts in that area mounted in value from a few million dollars to more than half a billion dollars to date.

Honoring Mr. Witter at the luncheon were B. C. Heacock, chairman of the executive committee, Caterpillar Tractor Company, the previous president of the San Francisco Post and new civilian chief of the San Francisco District; Col. J. M. Stark, deputy district chief; and G. M. Greenwood, vice-president of Rheem Manufacturing Company and president of the San Francisco Post of the American Ordnance Association.

Top military and civilian officials of the Ordnance District presented Mr. Witter with a citation in appreciation of his efforts in behalf of the Army program during his period of office.

Mr. Heacock, the newly appointed district chief, has been a loyal supporter of the American Ordnance Association for many years. The Association congratulates him on his fine leadership as president of the San Francisco Post and pledges him its full support.

General Medaris Delivers Principal Address at Meeting of St. Louis Post

Brig. Gen. J. B. Medaris was the honor guest and principal speaker at the annual meeting of the St. Louis Post held in the Boulevard Room, Hotel Jefferson, on January 7, 1954, at 6 p.m.

General Medaris, chief of the Industrial Division, Office of the Chief of Ordnance, delivered a most informative and timely address on "Reserve Ordnance Production Facilities."

"Last year the contractors of the St. Louis District produced more than 228,000 tons of ammunition," he said.

Presiding at the dinner meeting, which was attended by more than 450 members and guests of the Post, was Walter Siegerist, president of the Medart Company and Post president.

Coincident with this Post meeting, the quarterly meeting of the Ordnance district deputy chiefs and the commanding officers of the Ordnance arsenals and centers was held in St. Louis. This group was in attendance at the meeting and received merited applause for the outstanding work being done in the important fields of ordnance development, procurement, and production.

Following General Medaris' address an election of officers of the Post for the ensuing year was held at which Col. William P. Satley, of National Rejectors, Inc., was elected president.

The St. Louis Post was founded in 1927 under the guidance of the late Col. Harry Scullin who served as its president for many years. A great part of the Post's growth prior to the Second World War was due to the inspiration and industry of Col. Harold M. Reedall who for many years was deputy chief of the St. Louis Ordnance District. A close bond has always existed between the district and the Post in an area where the Industry-Ordnance relationship has great significance for the advancement of industrial preparedness.

• **A DONATION OF $539.62** was recently made by the American Ordnance Association to the Navy Relief Society. This sum was the excess of receipts over expenditures in connection with the Annual Industrial Preparedness Dinner Meeting of the Association held at the Waldorf-Astoria, New York City, on Wednesday, December 2, 1953.

The check was presented to Adm. Arthur W. Radford, Chairman of the Joint Chiefs of Staff, who was the honor guest and principal speaker at the meeting.

This donation was in accordance with the long-standing practice of the American Ordnance Association to donate the proceeds from such meetings to the relief organization of the service whose representative is honored or under whose auspices the meeting is held.

Thus, a check for $2,046.99 was presented to the commanding general of Aberdeen Proving Ground, Md.—this sum being the excess of receipts over expenditures for the Thirty-fifth Annual Meeting held at Aberdeen on October 8, 1953. This donation presented to the commanding general at the Proving Ground was made to the Army Relief Society.

• **AT WASHINGTON.**—The Post in our Nation's Capital welcomed a turnout of about one hundred and fifty members and guests at their meeting on January 21st to greet W. Hinman, Jr., technical director of the Diamond Ordnance Fuze Laboratories, Washington, D.C., the guest speaker.

Mr. Hinman was appointed director in September 1953 when the Ordnance research activities were transferred to the Department of Defense from the National Bureau of Standards. Before the transfer Mr. Hinman was associate director of the Bureau of Standards having previously served as chief of its Ordnance Development Division.

He joined the Bureau of Standards as a radio engineer in 1928 and has been active in the development of aircraft navigational aids, the radiosonde, and automatic weather stations. In 1940 Mr. Hinman became engaged in research and development of proximity fuzes.

He addressed the meeting on the problems of transition of military items from research and development to the production line.

• **THE MARINES.**—In a recent prize essay contest by the Marine Corps Association and its journal, the *Marine Corps Gazette*, Group I and "best essay" prizes totaling $1,000 were won by Lieut. Col. John J. Wade, Jr., U.S.M.C. Readers of ORDNANCE will be interested to know that the winner is Assistant Head of the Ordnance Branch (G-4) at Marine Corps Headquarters.

The prize-winning essay is entitled "Of Mortars and Men." In it Colonel Wade asks the pertinent and forward-looking question: "Are we hanging onto our mortars for sentimental reasons?" Acknowledging the splendid work of our mortarmen in World War II and Korea, he demonstrates that radar tracking will soon make mortar fire obsolete. He calls for a complete reappraisal of the field mortar's place in warfare and consequent readjustment in classification, placement, and numbers.

ORDNANCE congratulates the Corps on its aliveness to the ever-changing problems of weapons.

The Florida Post Holds Its Annual Meeting at Eglin Air Force Base

The annual meeting of the Florida Post was held at Eglin Air Force Base, Fla., jointly with the annual meeting of the Dimensional Standards and Metrology Division of the A.O.A.

The Post dinner meeting at the Shalimar Club on Thursday, January 7th, was attended by about forty members of the Technical Divisions and a good turnout of Post members. Brig. Gen. E. P. Mechling, commander of the Air Force Armament Center, was the able and genial toastmaster.

Joseph Weil, dean of the College of Engineering and director of the Research Laboratory at the University of Florida, was the guest of honor and principal speaker. He noted the many useful peacetime applications that had been derived from research under the impetus of war but pointed out that war should not be necessary to speed up research. The present need, he said, is to encourage more young men to undertake engineering in college since engineers are the backbone of advancement in research as well as industry.

Preceding the guest speaker, General Mechling, who represents the Post on the A.O.A. Council, introduced the following guests at the speakers' table: Brig. Gen. F. C. Sibert, U.S.A. (Ret.); Rear Adm. Dale Harris, chief, Naval Air Basic Training, Pensacola, Fla.; Col. G. H. Snyder, deputy commander, Air Force Armament Center; Col. J. B. Stanley, commander of Eglin Air Force Base; Col. P. S. Bechtel, new Post president; Lieut. Col. R. L. Dickson, retiring president; Brig. Gen. Burton O. Lewis and Capt. J. M. P. Wright, A.O.A. staff consultants; and Louis Polk, vice-president in charge of A.O.A. Technical Divisions and Committees and chairman of the Dimensional Standards and Metrology Division.

The newly elected and retiring Post presidents welcomed the guests, Captain Wright delivered a brief message from headquarters, and Mr. Polk outlined the aims of the A.O.A. and of the Technical Divisions and Committees under his direction.

The following day was devoted to reading and discussion of technical papers in the forenoon and a tour of Armament Center activities and a demonstration of some of the latest aircraft armament in the afternoon.

About twenty-five members stayed over Saturday to fish from a charter boat off the islands and reported a great catch of red snapper.

This joint Post and Technical Division meeting proved to be a very successful type of event. It is recommended that all American Ordnance Association Post presidents and Division chairmen consider such an affair in future plans.

Present at the Florida Post meeting were, left to right: Rear Adm. Dale Harris, Capt. J. M. P. Wright, Brig. Gen. Burton O. Lewis, Louis Polk, Brig. Gen. E. P. Mechling, Joseph Weil, Brig. Gen. F. C. Sibert, Col. G. H. Snyder, and Lieut. Col. R. L. Dickson.

Birmingham Post Hears General Vincent at Its Twenty-Fourth Annual Meeting

The twenty-fourth annual meeting of the Birmingham Post was held on December 10, 1953, at the Mountain Brook Country Club where 250 members and guests gathered to discuss industrial preparedness, meet new members, and welcome Brig. Gen. Thomas K. Vincent, commanding general of Redstone Arsenal, the guest of honor.

In the afternoon a large group from the Post visited the Englander Company's 155-mm. shell production line through the courtesy of the company plant manager, R. E. Bishop.

Prior to the dinner meeting the board of directors met to review the Post finances and receive reports from chairmen of the nominating and membership committees. A special award was proferred the secretary, Col. R. E. Parker, for his loyal and devoted work on behalf of the Post.

The dinner meeting was opened by election of A. V. Wiebel as president; Warren Whitney as vice-president; and a new roster of directors, as shown in the A.O.A. Directory for 1954.

Mr. Wiebel as toastmaster introduced the guests at the speakers' table who included Brig. Gen. H. N. Toftoy, director of the Guided Missile Laboratories, Redstone Arsenal; Col. H. G. Lang, deputy chief of the Birmingham Ordnance District; and Col. Leo A. Codd, executive vice-president of the A.O.A. Colonel Codd greeted the members on behalf of the national officers of the Association and spoke briefly on the aims and purposes of the organization.

The climax of the meeting was an illuminating talk on guided missiles and rockets by General Vincent. He noted that although the scientists at Redstone may probe the problems of space travel as an avocation, they work long hours at the arsenal on developing better rockets for immediate military application.

He pointed to the thousands of parts that must be made accurately and with extreme reliability as the big job for industry after Redstone has completed development. He told the meeting that members of the A.O.A. "are a vital force in this business along with Redstone Arsenal and your Government."

• **AT SYRACUSE.**—The Syracuse-Central New York Chapter of the Empire Post met on December 16, 1953, with over one hundred members present to elect new officers and hear Lieut. Col. Charles W. Luke, professor of chemical engineering, Syracuse University, discuss the principles of shaped charges.

Robert I. Hicks and Paul L. Christensen were reëlected president and first vice-chairman, respectively, and Richard W. Noyes, of Oneida, Ltd., was chosen as second vice-chairman. Gwyn Thomas will continue as secretary-treasurer.

• **AT PHILADELPHIA.**—The Philadelphia Post held a luncheon meeting of the board of directors on January 20th at the Union League Club. Col. A. W. Gilmer, Post president, presided over the meeting which was attended by all but a few members of the board and by Col. Leo A. Codd, national executive vice-president of the A.O.A., and Capt. J. M. P. Wright, staff consultant from A.O.A. headquarters in Washington.

Plans were discussed for a meeting in February at the new Philadelphia International Airport where it is expected that a demonstration of Piasecki helicopters will be given. After the demonstration the members will gather in the Airport Restaurant for dinner.

An equally important matter for consideration was how to increase membership. It was proposed that the members of the Post concentrate on company members and that as far as practicable the task of interviewing prospects be divided industrywise. In the discussion a strong point was made by Mr. Meinel, president of Heintz Manufacturing Company, who stated that he thought all patriotic industralists should be happy to join the A.O.A. as they would be better prepared from their close association with the services to mobilize their production for military use in time of war.

• **AT LOS ANGELES.**—A group of 300 members of the Los Angeles Post was fortunate to go out for sea maneuvers aboard the U.S.S. BREMERTON on January 28th. The BREMERTON is one of the Navy's heavy cruisers attached to the Pacific Fleet. Arrangements were made through the kind offices of Rear Adm. G. C. Dyer, commandant of the 11th Naval District.

The lucky 300 men embarked from Long Beach and spent a full day at sea off San Clemente Island where they witnessed drills in the turrets and antiaircraft batteries. They were given a firsthand look at the operations of a warship and the daily life at sea and an opportunity to

Attending the Birmingham Post meeting were, left to right: A. V. Wiebel, Post president; Col. H. G. Lang, deputy chief, Birmingham Ordnance District; Brig. Gen. T. K. Vincent, commanding Redstone Arsenal; and Brig. Gen. H. N. Toftoy, research director.

Gen. Matthew B. Ridgway, left, above, accompanied by Dr. John C. Adams, inspects the R.O.T.C. honor guard during his visit to Hofstra College, Hempstead, N. Y.

observe why accuracy and ruggedness are required in manufacturing material for the Navy.

• **AT HEMPSTEAD.**—The Ordnance R.O.T.C. Unit at Hofstra College, Hempstead, L.I., N.Y., furnished the honor guard for Gen. Matthew B. Ridgway, Chief of Staff of the Army, when he arrived to receive an honorary degree. He praised the guard by announcing that it "Holds its own against any other honor guard!"

The convocation for conferring the degree of doctor of laws upon General Ridgway was attended by all the Army and Air Force commanding generals in that area and many civilian dignitaries who heard the Chief of Staff deliver an inspiring and thought-provoking address. Hofstra College has the largest Ordnance R.O.T.C. Unit in the college training program of the Army and is consulting with the New York Post on forming a local chapter of the A.O.A.

• **COL. JAMES L. HATCHER,** an authority on small arms and small-arms ammunition and an officer of the Ordnance Department of the Army for more than thirty years, died at Durham, N. C., on January 5, 1954.

He was the brother of Maj. Gen. Julian Hatcher, also an ordnance authority in the field of small arms and presently technical adviser to the National Rifle Association. Both brothers became charter members of the American Ordnance Association.

Colonel Hatcher was educated at the Virginia Polytechnic Institute and was appointed second lieutenant in the Coast Artillery in 1916. He served with distinction in the First World War as a major in the 65th Artillery in France. After his return from that war he was transferred to the Ordnance Department where the remainder of his military service was given in addition to his special duties in connection with small arms and small-arms ammunition.

He served at armories, arsenals, and Ordnance districts where his talents and abilities were great assets in solving ordnance problems of the times.

• **DR. FREDERICK A. MAXFIELD,** prominent Naval ordnance scientist and one of the developers of the acoustical torpedo, died in Washington, D. C., on November 6, 1953.

A native of Milwaukee, Dr. Maxfield received his bachelor and doctor of philosophy degrees from the University of Wisconsin. He specialized in mathematics, physics, and electrical engineering. From 1929 to 1934 he worked with the Westinghouse Research Laboratory, returning to the university in 1934 as a professor. He taught there until 1941.

With the outbreak of World War II, Dr. Maxfield joined the Naval Ordnance Laboratory. One of his early jobs there took him to Pearl Harbor to work on degaussing materials which protected ships against magnetic mines.

The Navy Bureau of Ordnance in 1943 assigned him to work on the acoustical torpedo. Later he was the chief civilian scientist in the underwater ordnance section of the Bureau. He received the Distinguished Service Award for his Navy work.

In 1952 Dr. Maxfield left the Ordnance Bureau to establish the Given Manufacturing Company Research Laboratory in Washington, D.C.

• **COL. RICHARD F. POHLE,** of East Andover, N.H., died there on December 20, 1953. He was a charter life member of the American Ordnance Association and served in the Ordnance Department of the Army during the First and Second World Wars.

Born in Germany, Colonel Pohle had been a resident of Andover for the past twenty-eight years. He served as a lieutenant of Ordnance in the First World War, being promoted to the rank of major in the Ordnance Reserve. During the Second World War he rendered valuable service in the preparation of base shop data information at the Rock Island Arsenal, Rock Island, Ill. Subsequently he was assigned to the Pentagon where his professional mechanical engineering experience added to the high character of his patriotic contribution.

Colonel Pohle was also an artist of distinction, having exhibited his works in some of the leading centers. He had been associate editor of the *American Machinist* and collaborated in the publication of a book on mechanical illustrating.

As a tribute to his memory, a fund known as the Richard Pohle Fund is being established for landscaping and improving the area in front of the public buildings in East Andover. The square will be named in his honor.

• **LIEUT. COL. FRANK SHORT,** a charter life member of the American Ordnance Association and an officer of distinguished ordnance service in the First and Second World Wars, died suddenly on December 17, 1953, at Middletown, Conn.

Distinguished as an officer of the Army Ordnance Department, he served in Ordnance during World Wars I and II in assignments of high technical importance.

He is credited with having originated the camera obscura method of testing the trajectory of bombs and is also reported to have obtained in 1917 the first patent issued in connection with the polarization of light. He was one of the first American officers to obtain specimens of the German V-2 rocket for study in this country following the Second World War.

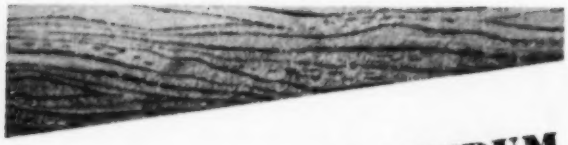
Born in Cleveland, Ohio, in 1890, Colonel Short was educated in British, Swiss, and German schools and was graduated from Cornell University.

He was associated with the Raymond Engineering Company of Middletown, Conn. Last year he was elected to honorary life membership in the Association.

• **CHARLES OWEN BURGESS,** internationally known metallurgist and technical director of the Gray Iron Founders' Society, died at his home in Cleveland on January 13, 1954.

Born at Little Falls, N. Y., in 1903, Mr. Burgess was graduated from Lehigh University in 1923 with the degree of metallurgical engineer. Prior to joining the staff of Gray Iron Founders' Society in 1948 he was head of the industrial service department of the Research Division of the Union Carbide and Carbon Corporation.

He held more than a dozen patents in the steel and gray-iron field and was also a well-known author of technical articles on the metallurgy of iron and steel.



MEMORANDUM

To: Ordnance Engineering Officers

From: Gear Specialists

Subject: Solution to Gearing Problems

For more than 50 years our engineer-specialists have successfully met and solved problems in the design and application of high precision gears.

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MATERIALS PROGRESS

George S. Brady

AN astonishing number of companies are now producing all types of small boats from glass-fiber-reënforced plastics. The boats range from rowboats and light outboard-motor craft to ketches, fast sailboats, fishing boats, and motor cruisers up to 36 feet long. Celanese Corporation of America (March Products Division) calls reënforced plastics "the modern material—the key to economical, low-upkeep small craft."

Polyester resins are the materials generally employed for such reënforced plastics, but a problem in the production of large plastic structures such as boats, truck bodies, tanks, and large appliance housings was that it was not possible to apply the heavy pressures normally used for small parts.

This problem has recently been solved in several ways. The Du Pont method is by treatment of the glass fiber with Volan. This material is a methacrylic acid with chromic chloride as a resonate bond in the molecule. In forming adhesion to the glass, the highly reactive resonate bond breaks down, losing the chlorine and chemically attaching the CrO to the silicon of the glass.

The glass fiber thus treated can be built up with a polyester resin into large structures with only very low pressures. Another improvement that has made possible large plastic structures of uniform high strength is the recent production of thixotropic polyester resins. These resins can be applied as liquids to vertical surfaces uniformly, and they will not drip or drain down.

The new Minisub, a 2-man submarine developed by the Aerojet-General Corporation, has the hull molded of a 2-ounce layer of glass mat between two single layers of glass cloth impregnated with polyester resin. The top canopies for visibility are made of transparent acrylic resin. The submarine, 12½ feet long, weighs only 155 pounds, with a one-horsepower motor to give a speed of 7.25 miles an hour. Auxiliary foot pedals are provided to give a speed of 6.3 m.p.h.

RECOGNIZING the increasing use of glass-fiber-reënforced plastics for larger products, Bigelow-Sanford Carpet Company, Inc., is producing glass-fiber mat in weights from 2 to 8 ounces in widths up to 144 inches. The company's new Rovmat is a high-tensile unidirectional mat with strands running in a longitudinal direction on a base of a chopped-strand carrier mat. Fabmat has a base of woven glass fabric to which a blend of chopped glass fiber roving is mechanically attached.

Molded Aqua-Glas plastic locker trunks, developed by the Army Quartermaster, weigh only 22 pounds complete with tray and hardware, compared with 44 pounds for older style locker trunks of vulcanized-fiber-faced plywood reënforced with metal corners. They also cost less.

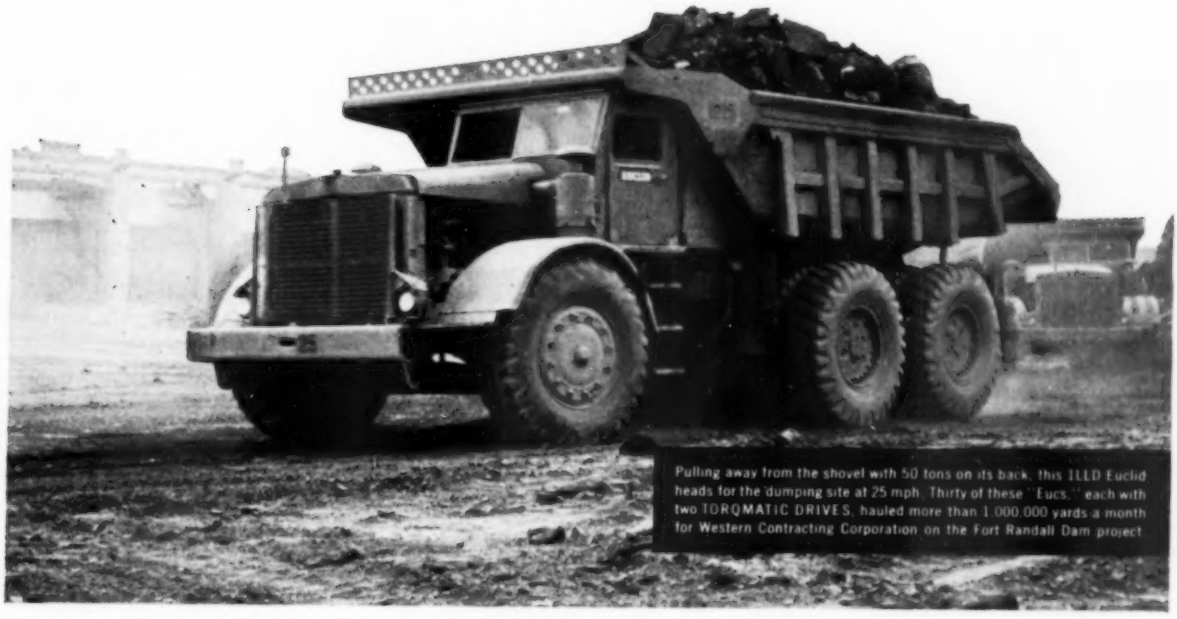
The Aqua-Glas is a mixture of 80 per cent cellulose fibers and 20 per cent chopped-glass fibers bonded with about 42 per cent of polyester resin. Flexural strength of the material is 31,600 p.s.i., and the specific gravity is 1.45. The thickness used is about 0.065-inch. Color is inherent, and no finishing is needed.

Laminated wood, impregnated and bonded with plastics, is also making a new era in building construction. Three new hangars at the Westchester County, N. Y., airport have 250-foot spans of laminated wood bowstring trusses. Navy minesweepers are also being made with laminated wood structural members, with preservatives incorporated in the plasticized wood.

A good example of the use of the new laminated woods in general construction is the new Lynnwood Junior High School

By any yardstick —

Transmission Life up 100%



Pulling away from the shovel with 50 tons on its back, this 1LLD Euclid heads for the dumping site at 25 mph. Thirty of these "Eucs," each with two TORQMATIC DRIVES, hauled more than 1,000,000 yards a month for Western Contracting Corporation on the Fort Randall Dam project

By any yardstick—miles, hours, ton-miles—truck transmissions *last twice as long* for Western Contracting Corporation since switching from direct-drive trucks to units equipped with Allison TORQMATIC DRIVES.

And "Rip" Collins, Project Manager, gives his TORQMATIC Converter-Transmission teams a major share of the credit for his perfect safety record in 1952: *No time lost due to accidents in 740,000 man-hours worked.*

Western's fleet of 30 Model 1LLD Euclids works 20 hours a day, 6 days a week. Making 700-900 trips per shift on a 3-mile round-trip run, these "Eucs" have hauled 6½-million yards of earth in six months' time. They climb 20% grades with 50 tons on their backs.

The TORQMATIC Converter absorbs harmful shock loads, protects drive lines, transmissions, differentials and other truck components. With no clutch pedal to push and only 3 forward speeds—instead of the usual 7 or 10—drivers quick-shift at full throttle and keep their eyes on the road, not on the gearshift.

If you are in the earthmoving business, do it better and at less cost with Allison TORQMATIC DRIVES in your units. Ask your equipment dealer, manufacturer or write:

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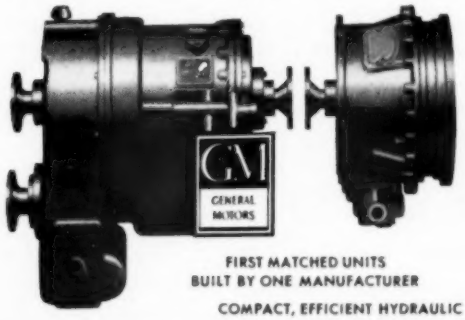
- **Reduces maintenance costs** by absorbing shock—eliminates engine lugging—prolongs equipment life
- **Only** torque converter-transmission team designed to work as a *unit* and built by one manufacturer
- **Cuts** driver training costs



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in Seattle. It has an entire wood frame with 53-foot beams and 92-foot arches of laminated structural wood.

But the new Army portable Quonset-shaped maintenance shelter has the framework made of magnesium alloy. The shelter is 66 feet long and 21 feet wide. It weighs only 2,090 pounds, and can be carried complete in five packages 4 by 10 feet by 15 inches, including the canvas casing. The magnesium arches are hinged and, when expanded for erection, are positioned on 4-foot centers by jackscrew purlins.

THE fabric casing is permanently attached to the frame by rope welts sewed to the canvas and threaded through openings on the under side of each arch, keeping the fabric taut and developing the ultimate strength of the canvas. It will withstand an 80-mile-an-hour wind with a good safety factor.

The new Air-Push motor of Sprague Devices, Inc., for operating the windshield wipers on heavy trucks, is made entirely of nylon except the screws and the stainless-steel shaft. Weight is only 10 ounces. It operates at air pressures from 5 to 120 pounds per square inch.

General American Transportation Company is injection-molding the large globes for the new General Electric street lamps which contain four 6-foot fluorescent tubes. The globes are molded in two sections of Rohm & Haas' Plexiglas acrylic resin. The material is tough and will not break like glass when hit with a stone.

About 110,000 square feet of corrugated methyl methacrylate has been installed in the ceiling of the Douglas Aircraft engineering department to give diffused wall-to-wall lighting over the large area without spot brightness at lamp areas. Until recently the cost of acrylate sheets was prohibitive for such installations, but the material, as now produced by the F. W. Wakefield Brass Company, is extruded continuously through a 45-inch corrugated die.

To meet the need of the developing cross-country movement of highway trailers on railway flatcars, the new Traileramp of the Magnesium Company of America is made of welded magnesium. It is 45 feet long and 9 feet wide but flaring to 12 feet at ground level to permit easy turning of trucks. It weighs 4,800 pounds but rides on rubber-tired wheels and can be positioned by two men.

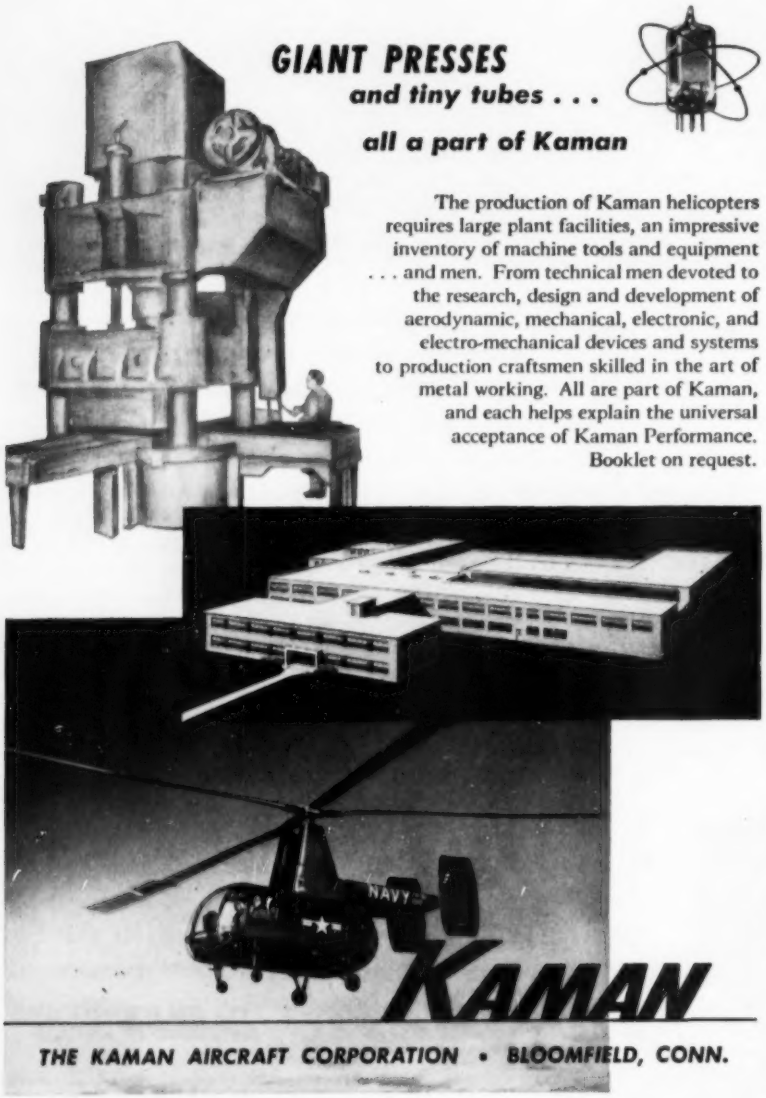
A new seating and upholstery fabric that has a woollike appearance and feel and still retains the nonstaining, mildew-proof, and fire-resistant qualities of synthetic fibers, is the Spun Boltaflex of Bolta Product Sales, Inc., which is woven from a combination of yarn spun from Dow Chemical's Saran (polyvinylidene chloride) and Saran monofilament. The fabric comes in seven different colors.

A new magnet material which has high coercive force (1,600 oersteds), and is made without the use of strategic metals, is being produced by the Indiana Steel Products Company under the name of Indox. It is made of iron oxide and barium carbonate, is lighter than metal, and is a nonconductor. A similar magnet material of the Ferroxcube Corporation of America, called Magnadur, is made with iron oxide and barium. Besides its high coercive force, it has high resistance to demagnetization.

NO scarce strategic asbestos is used in the new Kool-Suit garments made by Fyrepel Products, Inc., for the protection of industrial workers operating in high-temperature areas and for fire-control crews on naval ships. The garments are made of Fiberglas insulating mat faced on the outside with a reflecting aluminized glass cloth and on the inside with denim or flannel, the whole compressed to an average thickness of 3/8-inch.

The heat-stopping value is about 500 per cent greater than that of older types of heat-resistant garments, and the total weight of helmet, garment, and boots is only 26 pounds, or about one-fifth the weight of conventional protective garments. The helmet is connected to an air pack or an air supply line.

Noise and clatter of press operations has been reduced 50 per cent in the press room of John Volkert Metal Stampings, Inc., by hanging baffles vertically from the ceiling. The baffles are fiber glass boards 24 by 48 inches and one inch thick. A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The production of Kaman helicopters requires large plant facilities, an impressive inventory of machine tools and equipment . . . and men. From technical men devoted to the research, design and development of aerodynamic, mechanical, electronic, and electro-mechanical devices and systems to production craftsmen skilled in the art of metal working. All are part of Kaman, and each helps explain the universal acceptance of Kaman Performance. Booklet on request.
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"No matter how intelligent or industrious a man is, there is positive limitation on the amount of money he can earn in the service of his country. To those men who, through their own choice, renounce the chance of securing great material wealth and who consecrate themselves to the service of their country, we owe the assurance of a decent and comfortable standard of living not only through their period of active service but in the years of their earned retirement."

Secretary of the Navy
ROBERT B. ANDERSON

Here is a practical means of assuring a further productive life for retired service personnel: *Assist in the transfer of their skills to private industry.*

From every standpoint, this program makes sense: greater income and self-respect for the individual . . . added brainpower for industry.

So many companies have come to appreciate the technical background and executive ability of retired officers. The trend deserves encouragement by every industrial organization . . . that this potential may be fully utilized.

PRESIDENT

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GOVERNMENT

The Gray Manufacturing Company, Hartford 1, Connecticut
Makers of Audograph and PhonAudograph Electronic Soundwriters

AND GRAY RESEARCH AND DEVELOPMENT CO., INC., Specialists in Video, Audio, Sub-Audio Electronic Mechanisms

Make any parts like these...

Piston Pins
Pump Cylinders
Axles (front and rear)
Bearing (Races)
Airbrake Parts
Drag Links
Table Rollers
Exhaust Lines
Drill Shanks
Frame Spacers
Grease Guns
Armature Bodies
Hydraulic Brake Lines
Filler Tubes
Hydraulic Hoist Cylinders
Ignition Wire Tubes
Radio Parts
Bushings
Jacks
Gun Barrel Drills
Axle Housings
Propeller Shafts
Bobbins
Push Rods
Rocker-Arm Shafts
Hollow Spindles
Shock-Absorber Casings
Spring Bushings
Ironer Rolls
Tie Rods
Drill Collars
Torque Tubes
Spool Holders
Golf Shafts
Transmission Parts
Spindle Caps

better, faster and at less cost

with SHELBY SEAMLESS STEEL TUBING

BECAUSE Shelby Seamless comes to you with the basic shape and hole already made you can eliminate or greatly reduce many time and labor-consuming operations connected with boring and machining. You also save the wear and tear on expensive tools, as well as the needless waste of steel.

Another important advantage in using Shelby Seamless Tubing is that its excellent machining characteristics and uniformity speed up production and improve the quality of your output. *You can turn out parts by the millions and the last part will be as metallurgically and dimensionally accurate as the first part produced.*

Shelby Seamless Steel Tubing is available in a complete range of sizes; in different wall thicknesses; various finishes and steel analyses. Our engineers will be glad to submit recommendations based on a study of your particular requirements.

All Shelby Seamless Tubing is pierced from solid billets of uniform steel. This is the one manufacturing method that assures absolute uniform wall strength.

NATIONAL TUBE DIVISION
UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U·S·S SHELBY SEAMLESS MECHANICAL TUBING

USS

UNITED STATES STEEL

Materials Progress

thin plastic film covers the fibrous board to act as a diaphragm to transmit the sound waves into the air pockets of the fiber mat and to make it easy to keep the baffles clean.

The new Tiny-Mite transformers for guided missiles, transistor audio, and electronic uses where extreme compactness is needed, measure only ½-by 7/16-inch, with electrical characteristics to suit the application. They have nickel-alloy laminated cores with molded nylon bobbins on which the fine insulated wire is wound, and the whole is coated with a synthetic resin insulating varnish.

The success of the all-plastic oil pipeline from the Williston field in Montana may mark the beginning of a new era in pipeline construction, always a big consumer of metals. The 3-inch pipe is of cellulose acetate butyrate, and a 20-foot section weighs only 13 pounds compared with 153 pounds for a similar section in steel.

INSTALLATION costs were only 75 per cent as much as for steel pipe. Pumping costs are much lower because the coefficient of friction in the plastic pipe is lower, and there is no paraffin clogging. Maintenance costs are lower because no painting is necessary, no scraping of paraffin, and no sulphur corrosion.

The Signal Corps would not be defeated by those who said "it can't be done," and battery-grade manganese dioxide may soon be removed entirely from the list of scarce strategic materials. Western Electrochemical Company, whose officials give credit to the initiative of the Signal Corps, is now producing 10 tons a day of uniformly pure, high-grade battery manganese from low-grade local ores, with good prospects that all battery requirements can soon be met with domestic production.

High-grade natural battery manganese is produced only in Montana and the Gold Coast, most of the ore having been imported from the latter place. Battery manganese must be free of all metals that are electronegative to zinc, and it must have the peculiar gamma crystal structure that permits release of the oxygen for depolarizing the dry cell.

Western's new method is to roast the crushed ore to convert the oxide to monoxide, then leach out the heavy metals with sulphuric acid and precipitate with barium sulphide, aerate to oxidize the iron and sulphur, and finally electrolyze the solution to obtain a high-purity manganese oxide on the anode.

Another imported material that caused worry about supply during World War II was carnauba wax from Brazil, as there was then no good substitute for this hard, glossy, high-melting wax for making carbon paper, polishes, and coatings. But a Mexican company, Candelilla Industrializada, S. A., is now producing a wax comparable to carnauba by deresinating the more plentiful candelilla wax. The new wax, called Durango wax, has a melting point of 168 degrees Fahrenheit, and an iodine number of 9.

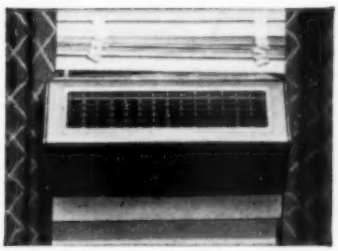
Still another good replacement for the scarce and expensive carnauba wax is sugar-cane wax, developed by Department of Agriculture technicians and now in commercial production in Louisanna by the Sugar Cane Wax Enterprise. Since three pounds of the wax can be obtained per ton of sugar cane, as a by-product easily recovered in the filter presses, unlimited quantities may also be obtained from near-by Cuba. The new Duplicane wax of the Warwick Wax Company is sugar-cane wax for carbon paper, and the new Technicane wax is a grade for polishes.

Chemical equipment manufacturers are making efforts to get away from the use of alloy parts that require nickel and other scarce strategic metals. A pump made by the Jabsco Pump Company for handling corrosive chemicals is an example. The pump has a plastic housing, a Neoprene impeller, and the shaft may be of Pyrex glass, stainless steel, or Hastelloy, depending on the required corrosive service.

A VITAL FORCE IN NATIONAL DEFENSE

Chrysler Airtemp

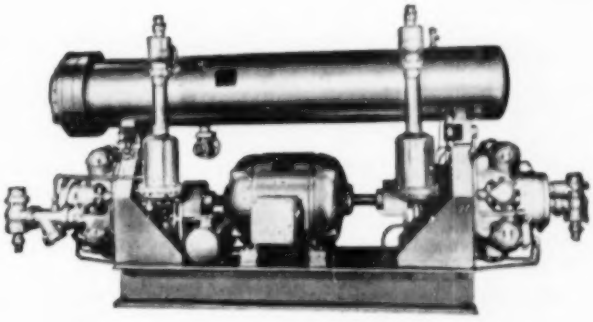
"Packaged" Air Conditioner
Easily installed. Cools, dehumidifies, filters, circulates, ventilates. Six water-cooled models, 2 to 15 H.P., and three new *air-cooled* models, which operate without water, require no plumbing, in 2, 3 and 5 H.P.



Room Air Conditioner
Fits in window. Cools, filters and circulates outside air. Ideal for offices, hospital convalescent rooms, workshops and other small areas. New model now available for use in casement type windows.

Chrysler Airtemp has won recognition as an outstanding factor in the national defense effort. By waging war against enemies of production, precision and perishables: uncontrolled dust, humidity and temperatures—Chrysler Airtemp is making a major contribution to the armament program. On all fronts—at home and abroad—in assignments that cover every application of temperature and humidity control, Chrysler Airtemp is serving with distinction. A complete range of products enables Chrysler Airtemp to provide the answer to production problems involving control of indoor atmospheric conditions.

Machine Tool Coolant Cooler
Keeps coolants in automatic machine tools at a constant temperature. Helps provide greater precision, higher production. Reduces friction heat.



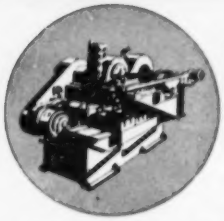
Central Station Unit
For large installations. This unit forms the heart of many air conditioning, cold storage and other temperature and humidity control systems.

Chrysler Airtemp

HEATING • AIR CONDITIONING
for HOMES, BUSINESS, INDUSTRY

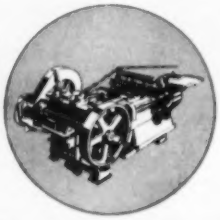
Airtemp Division, Chrysler Corporation, Dayton 1, Ohio

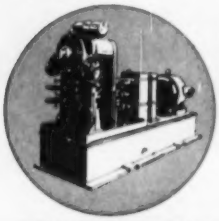
FIVE KINDS OF MASS PRODUCTION METALWORKING MACHINERY by Waterbury Farrel



COLD PROCESS BOLT & NUT MACHINERY —Headers (all types) • Rivet Machinery Trimmers • Thread Rolling Machines Slotters • Nut Formers and Tappers, etc.

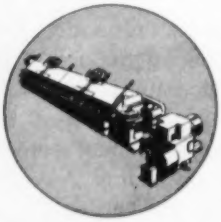
POWER PRESSES — Crank, Cam and Toggle; also Rack and Pinion Presses • Eyelet Machines • Multiple Plunger Presses • Horizontal and Hydraulic Presses, etc.

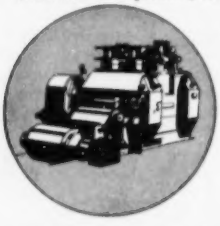




MILL MACHINERY — Rolling Mills: Strip, Rod, Tube, Wire Flattening, (For Ferrous and Non Ferrous Metals) • Also Slitters • Straighteners • Cut-off Saws • Coilers • Winders, etc.

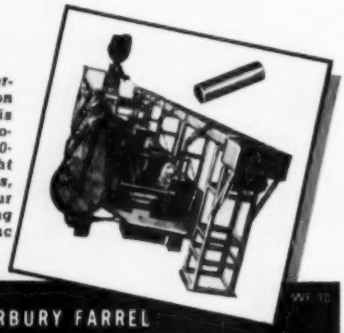
WIRE MILL EQUIPMENT — Continuous Wire Drawing Machines (Upright Cone and Tandem) • Wire Flattening Mills • Chain Draw Benches • Pointers • Swagers • Bull Blocks • String-up Machines • Spoolers, etc.





SPECIAL MACHINERY — Sendzimir Mills • Small Arm Ammunition Machines • Thread Rolling Machines For Shells • Collapsible Tube Machines • Coining Mills, etc.

HERE'S A SAMPLE of Waterbury-Farrel mass production equipment in action. This complete WF automatic production unit combines a 40-ton double-acting, upright blanking and cupping press, a conveyor feed and four 7-station horizontal drawing presses to draw 340 zinc shells per minute.



WATERBURY FARREL FOUNDRY & MACHINE CO.
WATERBURY, CONN.
Offices: Chicago, Cleveland and Millburn, N. J.

Materials Progress

Balsa wood, imported from Ecuador, was formerly used to fill voids along the water line of aircraft carriers to prevent excessive listing in case the hull was pierced. It was an expensive job, as the wood had to be hand fitted. Now, the space is filled with foamed plastic. A liquid phenolic resin is used containing bicarbonate of soda. An acidic catalyst reacts with the soda, liberating carbon dioxide gas which expands the plastic into a light cellular structure which completely fills the space.

Useful for factory hospitals, and for isolated mining and mill establishments, is a new combination stretcher and cot being produced by the Simmons Machine Tool Company. Made of extruded aluminum tubing and die-cast aluminum end sections and feet, it weighs only 27 pounds, is 4 inches wider than an ordinary litter, and has hinged feet that permit the litters to be stacked as bunk beds.

A NEW Lanco sink drain and trap, of Arthur S. Lapine & Company, gets away from the time-honored old lead metal drain and is made entirely of polyethylene plastic. Since it is resistant to acids, alkalies, and many chemicals, it is especially suited for sinks in laboratories, plating rooms, and chemical plants. The design departs from the ancient hard-to-clean welded-pipe construction, and is made as a unit with union outlet, easily detached by hand for cleaning.

Pure nickel non-woven screens, which were developed for jet aircraft filtration, are being offered by the Pyramid Screen Company for any applications requiring corrosion resistance at high temperatures. The screens are electrolytically deposited, and they are in the form of rigid smooth sheets with greater stiffness than woven-wire screens and are easier to clean. Also, there are no edges to unravel. Openings as fine as 0.001-inch may be had, and the holes may be round, square, or slotted, and are conically shaped to give less tendency to clog.

To produce a black metal sheet that will give a high thermal emittance value for electronic applications with a substantial saving in strategic nickel, Sylvania Electric Products, Inc., has developed Carbostrip. The base metal is an aluminum-deoxidized steel of 0.013 per cent maximum carbon. A 10 per cent by weight coating of nickel is plated on one or both sides of the steel.

It is then coated with 5 per cent by weight of nickel oxide by a slurry process, which is reduced in a hydrogen furnace to a spongy layer of nickel. This sponge is impregnated with a carbon slurry to form the black carbonized surface. The strip can be had in widths to 7 inches.

The new Indox 1 magnet material of the Indiana Steel Products Company presents the possibility of obtaining permanent magnets for electronic and electrical applications without the use of scarce strategic nickel and cobalt. The material is not an alloy but a ceramic. It is made by molding barium carbonate and ferric oxide under high pressure and sintering in a furnace at high temperature.

The resulting material has the chemical formula $BaO\ (Fe_2O_3)_6$, with a hexagonal crystal structure that has only one easy direction of magnetization parallel to the crystal axis, whereas such metals as iron, with a cubic crystal structure, have three easy directions of magnetization. It does not have to be magnetized in place like the cobalt magnets. It also has an advantage in light weight, with a specific gravity of 4.5, compared with about 7.17 for a cobalt magnet.

The coercive force of Indox is 1,600 oersteds, while a high-grade cobalt magnet alloy with as much as 24 per cent cobalt and 18 per cent nickel has a coercive force of only 1,300 oersteds. Magnets can thus be made shorter to fit into confined spaces such as are often encountered in electronic devices.

While metal-alloy magnets are electrical conductors, the electrical resistivity of the ceramic is so high that it may be considered as a nonconductor, making eddy current losses low.

PFC STALLION U.S. CALVARY (RETIRED)
Though my ancestors carried Revere and Custer,
Employment has gone from bad to 'wuster'
Today, Ordnance knows that REO horsepower
Hauls everything better . . . at more miles per hour.
Definitely . . .
an EAGER BEAVER
KEEP YOUR GUARD UP!
JOIN THE NATIONAL GUARD

REO MOTORS, INC. • Lansing 20, Michigan

GOVERNMENT FINISH SPECIFICATIONS

and the Parker Products which meet them

This list contains specifications most frequently called for, and some of the Parker Products which meet them. There are Parker Products to meet almost every one of the less frequently used government specifications also. A letter or telephone call to Parker, Detroit, will secure specific information on products to meet government specifications not listed here.

SPECIFICATION	PARKER PRODUCTS
JAN-C-490 (Replaces AXS-1245)	
Grade I	Bonderite 100, 160, 170, 180
Grade II	
Type 2	Parco Cleaners 341, 350, 371
Type 4	Parco Cleaners 250, 260
Type 5	Parco Cleaners 210, 220
Type 6	Parco Cleaners 100, 101, 110
MIL-10578 (Formerly U.S.A. 3-213)	
Type I (Wash-off)	Parco Cleaner 250
Type II (Wipe-off)	Parco Cleaner 260
MIL-C-5541 (Formerly AN-C-170)	Bonderite 710 (chemical film for aluminum and its alloys)
MIL-C-12968 (ORD) (Supersedes in part U.S.A 57-0-2)	
Type A—(Formerly U.S.A. 57-0-2, Type I, Class A & A1)	Parco Powder, Parco Lubrite 1 & 2
Type B	
Class 1 (Formerly U. S. A. 57-0-2, Type II, Class B	Parco Compound
Class 2	Parco Compound plus Endurion
MIL-C-16232 (BuORD)	
Type I	Parco Lubrite 1 & 2
Type II	Parco Compound
PA-PD-191	
Grade I	Bonderite 32, 34, 100, 160, 170, 180
Grade II	
Type 2	Parco Cleaners 341, 350, 371
Type 4	Parco Cleaners 250, 260
Type 5	Parco Cleaners 210, 220
Type 6	Parco Cleaners 100, 101, 110
U.S.A. 72-53	Bonderite 32, 34, 100, 160, 170, 180
U.S.A. 57-0-2 [See also MIL-C-12968 (ORD)]	
Type II	
Class A & A1	Parco Lubrite 1 & 2
Class B	Parco Powder—Parco Compound
Class C	Bonderite 100, 160, 170 180

For information regarding these or other specifications, write

PARKER

RUST PROOF COMPANY

2165 E. Milwaukee Ave., Detroit 11, Mich.

FIRST IN THE FIELD SINCE 1915

NEW DEVELOPMENTS

HOT EXTRUSION OF SHELLS

Development of an improved hot metalworking process affecting significant cost reductions in manufacture of mortar and artillery ammunition has been announced by Scaife Company of Oakmont, Pa. This development, a modification of the Ugine-Sejournet extrusion process using glass as a lubricant, produces a 4.2-inch shell in one piece from a simple billet and, it is claimed, with improved quality and significant savings in cost and materials. Important features of the development are in the substitution of readily available billet stock for seamless steel tubing, a critical material in times of emergency, as well as a saving of twenty-five per cent in steel used.

MECHANICAL MULE

"Mechanical Mule" is the name and function of the Army's new XM274, a lightweight, highly mobile vehicle designed for use by combat troops in forward areas. Four-wheel drive and four-wheel steering, which can be operated from positions on or off the vehicle, have also been incorporated.

The Army's new lightweight weapons carrier.

THE ATOMIC SUBMARINE

The U. S. submarine NAUTILUS, launched at Groton, Conn., on January 21, 1954, will be powered by the first atomic engine ever to propel a ship. Capable of propelling the NAUTILUS to speeds of more than 20 knots while submerged, this atomic engine brings to reality the dream of useful power extracted from the same material—uranium 235—that was the heart of the first atomic bomb. Because a nuclear reactor of this type does not require oxygen for its operation—as does a combustion engine—the vessel will be able to operate at top efficiency for long periods of time while submerged. It thus will be the first true submarine.

HIGH-POWERED TURBOJET

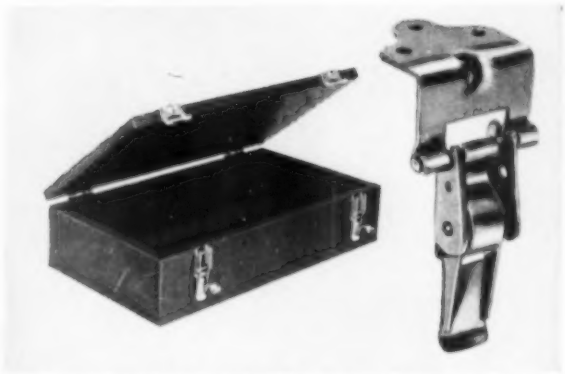
The United States now has in quanity production a turbojet aircraft engine with an official rating in the 10,000-pound-thrust class. The engine is Pratt & Whitney Aircraft's J-57 which powers the Air Force's new heavy jet bomber, the Boeing B-52 Stratofortress, and the new supersonic fighters, the North American F-100 Super Sabre and the Convair F-102. The J-57 is also slated to power the McDonnell F-101 and Navy aircraft. The engine has a lower specific fuel consumption than any other turbojet presently in production for the Air Force, plus a rapid rate of acceleration.

Have you a fastening or clamping problem?

IF YOU HAVE, CHANCES ARE BASSICK HAS A DEVICE TO SOLVE IT

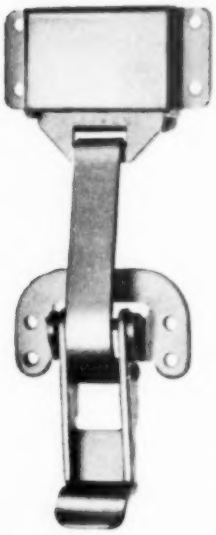
Catches and fasteners, for everything from jeep hoods to tool boxes, kits, and containers, are available from Bassick . . . either "standard", like the four shown, or adaptations to meet your special needs by Bassick development engineers working with you.

For many years, Bassick has been a leading supplier of specialty hardware to the automotive and other top industries . . . in addition to being the world's largest manufacturer of casters.



Combination Latch-Hinge (ZLA-1020, ZLA-1009)

A truly versatile fastener! Clamps on one side in locked position are acting as hinges, while the clamps on the other side are open, permitting entrance to the box, which can be opened from either side. Lid easily removed by unlocking all four fasteners.



Back View

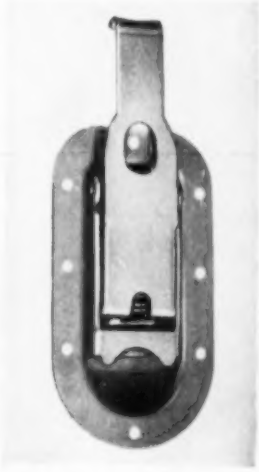
"Power-Pack" (ZLA-1104)

This behind-the-catch view shows why this clamp won't loosen even under the roughest handling or vibration. There are *100 lbs. of tension* compressed in these springs, but it is not a "knuckle breaker"! Ideal for operation in sub-zero temperatures.

Flush Type Clamp Assembly

(ZLA-1098)

These clamps are fully recessed to allow close stacking of the crates, boxes, etc., on which they're installed. Arm is spring-loaded to work easily and grip the latch firmly. Hole for inserting padlock or shipping seal.



Heavy-Duty Hood Fastener

(C-4017)

"Catching" vehicle hoods is but one of the many uses for this type of fastener. It always provides a dependable and economical "hold", yet allows easy access to encased units. Bassick makes many sizes and styles.

Write for Specialty Hardware Catalog, showing our extensive line, or address your problem to THE BASSICK COMPANY, Bridgeport 2, Conn. *In Canada*: Belleville, Ont.

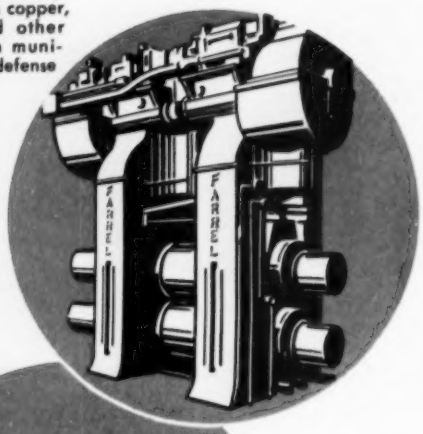
Bassick

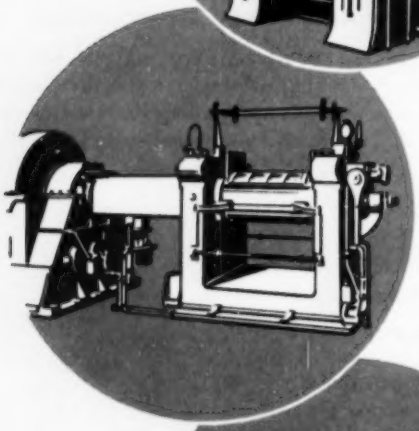
A DIVISION OF STEWART SW WARNER

MAKING MORE KINDS OF CASTERS . . . MAKING CASTERS DO MORE

3 typical examples of Farrel® DEFENSE engineering

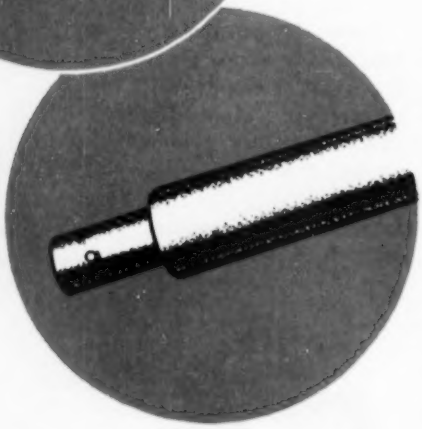
Mills for rolling cartridge brass, as well as copper, aluminum and other metals used in munitions and other defense supplies.





Roll mills and calenders for the manufacture of explosive powder.

Molds for the centrifugal casting of gun barrels of 3-inch, 75-mm, 90-mm, 105-mm and other calibers.



These are only a few of the many diverse products designed and manufactured by Farrel for defense plants. For further details send for a copy of Bulletin No. 55B.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT
Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
FB-903

Farrel-Birmingham®

New Developments

ATOMIC SAFETY DEVICE

An atomic safety device is helping punch-press operators escape injury from their machines. The system, designed by Hazatrol, Inc., of Berkeley, Calif., uses the "radiation detection" principle to prevent accidents. Already installed at the United Air Lines' maintenance base in San Francisco, it works as follows:

Three geiger tubes, sensitive to the close presence of any radioactive materials, are fitted around the punch-press work zone. Before a worker operates the press, he first dons two wristbands containing radioactive crystals. Then, should his hands approach danger areas guarded by the geiger tubes, the machine immediately stops, saving the operator from possible injury. It is claimed to be sensitive enough to stop the punch press in midstroke.

NEW RADIO EQUIPMENT

The "Angry 3-8"—a brand new series of radio equipment—now is on duty with the Army's combat divisions in Korea. Officially designated the AN/GRC 3-8 by the Army Signal Corps, the "Angry 3-8" is a standardized frequency-modulation radio-voice set. It is replacing the older-type communications equipment used by combat units in their vehicles.

The main advantage of the "Angry 3-8" series is found in its tuning and compactness. Where the older sets had 120 channels—only 10 of which could be used at one time—the new models allow as many as 170 channels to be utilized without presetting. The number of channels available depends on the combination of units being used.

ALL-WEATHER FIGHTER

The Navy recently accepted the first production model of the McDonnell F3H-1N all-weather high-performance carrier-based fighter. The single-jet plane, called the "Demon," combines interceptor speed and fighter maneuverability with the pay load of an attack bomber.

Thin wings and tail surfaces of the new Navy fighter are swept sharply back to give the big plane high operational speeds. The large amount of internal fuel carried gives the Demon the necessary range for fighter-bomber missions. All internal fuel is carried in self-sealing fuel tanks, but for longer missions external fuel tanks can be carried. Armament consists of a fast-firing, high-velocity 20-mm. cannon and multiple combinations of external stores, including a large number of air-to-air rockets.

RADAR CHECKS BROADCASTS

Military secrecy was recently lifted from the new radar device, "COZI," developed by Raytheon Manufacturing Company in cooperation with the United States Air Force. COZI ("Communications Zone Indicator") makes it possible to tell whether broadcasts from international short-wave stations or any other long-range transmitters are successfully reaching their destinations. It also indicates approximately how strong the broadcast signals are when they get there and may show whether the enemy is deliberately "jamming" that particular frequency with static and interference.

To test a radio signal, COZI sends out a radar beam from the station's own antenna. The beam follows the same path taken by the radio waves. The difference, however, is that the COZI beam comes back and tells where it has been and often whether it has run into any interference at its destination.

INDICATOR FOR GASES

A low-temperature instrument that measures, indicates, records, and control the level of liquefied gases such as hydrogen or nitrogen has recently been developed by W. E. Williams and E. Maxwell of the National Bureau of Standards with the

What do you know about Dana?

Charles A. Dana

The Dana Corporation comprises a group of industries that is widely diversified in lines of manufacture. Its principal service is to those companies producing passenger cars, trucks, buses and tractors, and other self-propelled vehicles, for civilian and military use. Many Dana products are used in the aircraft industry, and as components in a wide range of machinery and appliances.

The Dana Corporation had its founding in the Spicer Corporation in 1904. This company was formed by Clarence W. Spicer, inventor of the first commercially-produced automotive universal joint. Spicer Joints now are used as standard equipment on a majority of the world's automotive vehicles. Today the Dana Corporation produces in its 10 modern domestic plants, and associated plants in Canada, Great Britain and France, the following products: transmissions, universal joints, propeller shafts, Brown-Lipe and Auburn clutches, forgings, axles, stampings, Spicer Brown-Lipe gear boxes, Parish frames, torque converters, power take-offs, power take-off joints, rail car drives, railway generator drives, aircraft gears, and welded tubing.

THIS IS SPICER IN FORT WAYNE, INDIANA

The Salisbury Axle Division of Dana Corporation is devoted exclusively to the manufacture of the Spicer Salisbury Axle, widely used in automobiles, taxicabs, and light trucks

For nearly 50 years, "SPICER SALISBURY" has meant *quiet axles*

The Spicer Salisbury Axle for passenger car and light commercial use is engineered for long, quiet life. It offers these special features:

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Now that the military models developed jointly with Army Ordnance are available for civilian uses, you can get Continental power for commercial applications at just about every power level from a lawnmower up to a tank. These air-cooled military series, from 375 to more than 1,000 horsepower, have been thoroughly proven under combat conditions. Their performance has been such as to forecast their adoption for many civilian jobs, especially those requiring high power-to-weight ratio, ease of maintenance, and stamina for sustained peak loads. If your needs fall between 2 and 1,040 horsepower, you'll fill them *best* with the Continental Red Seal engineered and built to your job.

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For features, specifications, and optional equipment, write for Sub-Arctic Bulletin.

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Engineers and Manufacturers of Automatic Environmental Test Equipment

New Developments

coöperation of the Brown Instrument Division of Minneapolis-Honeywell Regulator Company. This electronic instrument operates on the capacitance principle and makes use of the difference in dielectric constants of the liquid and vapor states. The sensing element is a vertical cylindrical capacitor whose capacitance is a function of the height of the liquid refrigerant column.

The NBS instrument is designed to be used interchangeably with hydrogen, nitrogen, oxygen, or helium merely by changing the sensitivity and range controls on the associated electronic circuitry. It also incorporates a control system that maintains the liquid level at a predetermined point.

NEW RESEARCH WIND TUNNEL AT ABERDEEN

The supersonic wind tunnel facility of the Ballistic Research Laboratories at Aberdeen Proving Ground, Md., recently installed a new $120,000 research tunnel. The new tunnel, first of two ordered by the Laboratories, is designed for research programs in boundary-layer investigation, tunnel-design problems, calibration of tunnel instrumentation, and other similar technical studies.

The research tunnel's testing section, where the material to be tested is installed, measures 5.75 inches high and 5.75 inches wide. The height may be increased to twelve inches. The new tunnel is supersonic and has a Mach number range of five times the speed of sound.

SAW CUTS GLASS

A new and faster method of cutting glass melamine, made possible through special adaptation of a stone saw, has been introduced at the Boston Naval Shipyard. Besides cutting glass melamine up to two inches thick at the rate of four feet a minute, this tool is reported to be easily adaptable for cutting granite, marble, tile, slate, brick, structural glass, plastic, refractories, and asbestos products. By attaching abrasive cutting wheels to the machine, many types of metal can be cut with greater speed and accuracy than by conventional methods.

NEW AIR TRAFFIC CONTROL

A revolutionary electronic device for controlling incoming planes at busy air bases was recently disclosed by scientists of the U. S. Air Force's Cambridge Research Center. Known as "Volscan," it is an automatic system for bringing aircraft into a base at precise intervals of thirty seconds. In thousands of flight tests with many types of jet and propeller-driven planes during the past year, the system has proved to be the long-sought means of eliminating the "stacking up" of planes over busy military and civilian airports.

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offers the advantages of two braking systems in one unit

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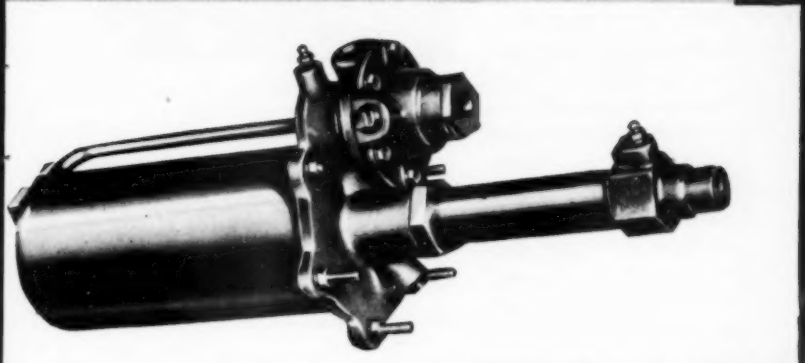

With Bendix® AIR-PAK you get faster brake action and more positive control, for here in a single, compact easy-to-install power braking unit are combined the well proven advantages of hydraulic brake action with an air brake system.

Bendix AIR-PAK changes air pressure into hydraulic pressure by means of two directly connected pistons. Thus, a non-compressible column of brake fluid instead of air connects between the driver's foot and the brake shoe. If in an emergency situation air pressure fails for any reason, or if braking is required before air pressure builds up, brakes can be applied instantly by foot power alone.

AIR-PAK is the product of Bendix—world's largest producer of power brakes and builder of Hydrovac®, the world's most widely used power brake with *over three million units in use.*

For truck manufacturers or operators interested in AIR-PAK, a descriptive folder is available on request.

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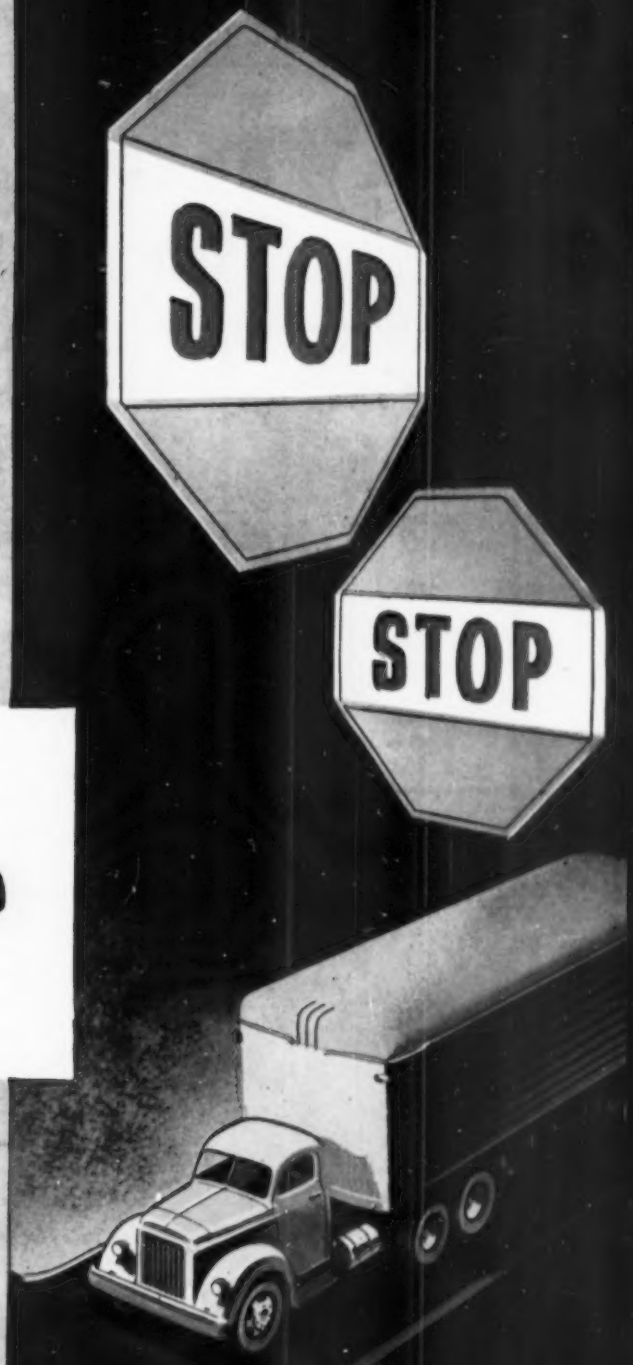

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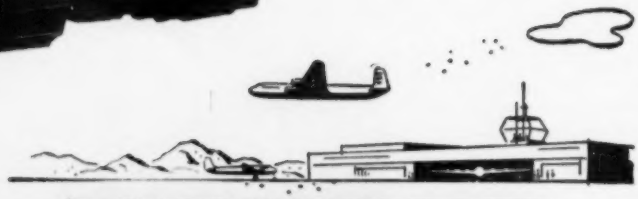
Consult BREEZE engineers for the newest in electrical, mechanical or hydraulic hoists to meet individual conditions.



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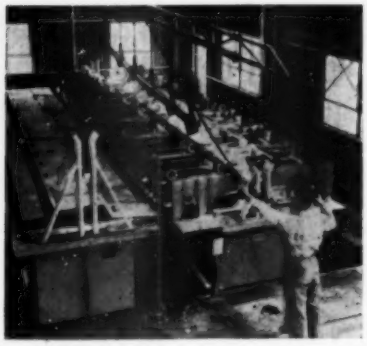
Actuators • Ignition Shielding • Aero-Seal Worm Drive Hose Clamps

New Developments

The system is not a radar set; rather it is a combination of electronic, tracking, and computing units which are capable of automatic control of all planes approaching an airport.

SPARS GET SALT BATH

Steel spars, the main load-carrying members of a helicopter's rotor blades, are now being martempered in what are believed to be the world's longest salt baths used for isothermal quenching. The unique treating process, recently unveiled at the



Spar is lowered into salt bath.

Piasecki Helicopter plant in Morton, Pa., is currently used for hardening spars for Piasecki's H-21 "Work Horse" which set two helicopter world records at the National Air Show, Dayton, Ohio—for speed (about 147 m.p.h.) and altitude (22,289 feet).

RAPID AERIAL DELIVERY

A new method of parachuting heavy equipment to forward-area troops has been devised for the C-124, the Air Force's largest production cargo aircraft. Conceived and tested by the Air Research and Development Command and the Douglas Aircraft Company, the system enables each C-124 aircraft to drop a total of 40,000 pounds in a few seconds. The new system employs a pair of rails, a chain drive, and specially designed pallets to move the cargo out of the aircraft quickly. The entire delivery system weighs only 2,800 pounds and requires only minor structural modification of the aircraft.

ELECTROSTATIC GENERATOR

A miniature electrostatic source of high voltage for use with radiation survey instruments has been developed by S. R. Gilford, S. Saito, and J. L. Herson of the National Bureau of Standards. The device is an adaptation of the work of Holtz and Wommelsdorf on influence-type generators of conventional size, but it uses modern printed-circuit and miniaturization techniques. Operation of this type of generator depends on the ability of one

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- **Nu-Chromseal** is a solid, pliable compound in a film of fixed thickness for sealing lap joints or butt seams in metal, wood or fiber.
- **Fabseal** is an impregnated fabric for sealing between metal, wood or fiber members.

• • •

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Engineers and others desiring careers in the field of small turbines are invited to write, giving background and type of work desired.

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A SUBSIDIARY OF CONTINENTAL MOTORS CORPORATION

New Developments

charged body to induce a charge on another body close by. The device is one result of a program sponsored by the Navy Bureau of Ships for the investigation and application of techniques adaptable to low-cost mass production of radiation survey instruments.

TELL-TALE PAINTS

The extreme heat generated by jet engines and guided missiles calls for a new approach to temperature measurement. A promising new thermometer consists of paint which changes color with variations in temperature. Scientists at the Naval Research Laboratory have been able to establish a series of compounds that will record temperatures from 50 to 278 degrees Centigrade.

PORTABLE UHF SET

The Air Research and Development Command has announced production of the first ultrahigh-frequency portable communications set developed by the electronic research laboratories of the Rome Air Development Center at Griffiss Air Force Base, Rome, N. Y.

The set is manufactured by Air Associates, Inc., Orange, N. J. The new electronic product weighs but half that of the presently used communications sets while having a greater range. It is considerably different in electronic and physical makeup and marks an improvement over present front-line communications facilities.

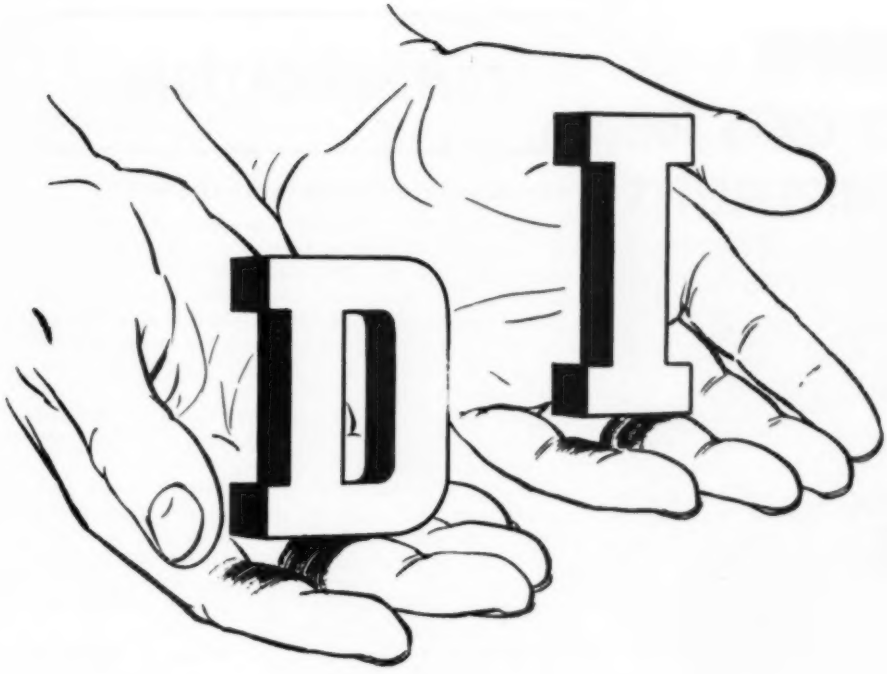
Structural parts of the set are made largely of magnesium and aluminum. It fits snugly on the chest by means of the conventional infantryman's shoulder harness.

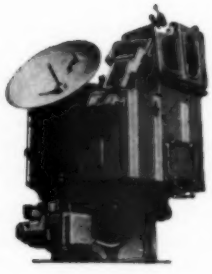
OPTICAL PYROMETER

An instrument that measures the instantaneous temperature of flames in rocket and other combustion engines has been devised by physicists in the Research Division of New York University's College of Engineering.

The new optical pyrometer allows engineers to follow the temperature in engines as it fluctuates throughout the complete engine cycle. This method of evaluating engine efficiency will contribute a basis for engine design and improvement.

The instrument employs the "2-path" technique, using two photoelectric cells. Acting as pickups, the cells "look" along almost the same line of sight. One looks to a black background. The other looks through the flame to a mirror and "sees" a flame thickness twice that of the first cell. The instrument eliminates the necessity of knowing explicitly the flame emissivity—the ratio of radiant energy emitted from a body to that emitted by a theoretically perfect radiator at the same temperature.





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Skilled hands—1500 pairs of them are busy every day at Daystrom Instrument—performing research, development and manufacturing tasks on a wide variety of precision electrical and mechanical instruments. Daystrom specialists are prepared and ready to analyze your requirements and translate them from drawing board to finished products—all within our own modern plant of 350,000 square feet. All development and manufacturing are achieved through advanced techniques. We are proud of the fire control and radar equipment we produce for our Army and Navy. Daystrom products include computors, gyros, servo amplifiers, electronic chassis, sheet metal cabinets, test equipment, gear assemblies, servo controls, radio and precision potentiometers.

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COMMUNICATIONS

"THE ORIGINAL CONFEDERATE COLT"

THE EDITORS.—Your November-December 1953 issue contained a review by Col. Calvin Goddard of "The Original Confederate Colt." The colonel was very much unimpressed by this book. He set forth his opinions in ten lethal paragraphs, seven of which were devoted to disproving the title of the book. One paragraph dealt with the publisher's format and printing. I will quote the slightly smaller of the two remaining paragraphs which covered the contents of the book itself:

"To me, the book, which borrows many passages from Fuller and Steuart's 'Firearms of the Confederacy' without giving credit for any of these, is a distinct disappointment."

I am sorry I let the colonel down, although it is not of his disappointment that I write, and not one printed word of mine would ever appear to refute his evident poor opinion.

The accusation of not giving credit where credit is due is another matter and represents the expression of something more than the colonel's opinion, and with this I am concerned sufficiently to write to you.

"Firearms of the Confederacy" was written by Richard D. Steuart and Claud Fuller in 1944. It is the "bible" of every Confederate arms collector and will so remain for years to come. It is remarkably thorough and complete. Of necessity, almost any future writing which pertains to Confederate sidearms will be an enlargement of this work.

As every one knows, Mr. Fuller's talents were devoted to the "longarm" section of this book; the "handgun" section came entirely from Mr. Steuart. I say "entirely" but actually mean that he was expressing the knowledge he had gained through personal experience plus the combined knowledge of hundreds of collectors with whom he corresponded, principally E. Berkley Bowie, C. L. Quick, and L. D. Satterlee.

Richard Steuart died in the fall of 1951. Following his death his voluminous files and papers on arms passed into my hands, being given to me by his brother. In my esteem Dick Steuart was outranked only by Robert E. Lee. He had been a close personal friend of mine for over twenty-five years.

He and I had coauthored a small booklet on Confederate swords. My regard toward him and "Firearms of the Confederacy" can be found in an article, "Confederate Handguns," which appeared in your November-December 1951 magazine.

Upon writing the "Original Confederate Colt" a year after the death of Richard Steuart, I knew of no higher way to show my affection toward this splendid person than to include his name as coauthor in a series of books which I am presently engaged in writing and which are in part based on some of his manuscripts.

There is no secret about this. This information is contained on the paper jacket of "The Original Confederate Colt" which also states: "Richard Steuart is best known for his monumental work 'Firearms of the Confederacy' written with Claud Fuller and published in 1944."

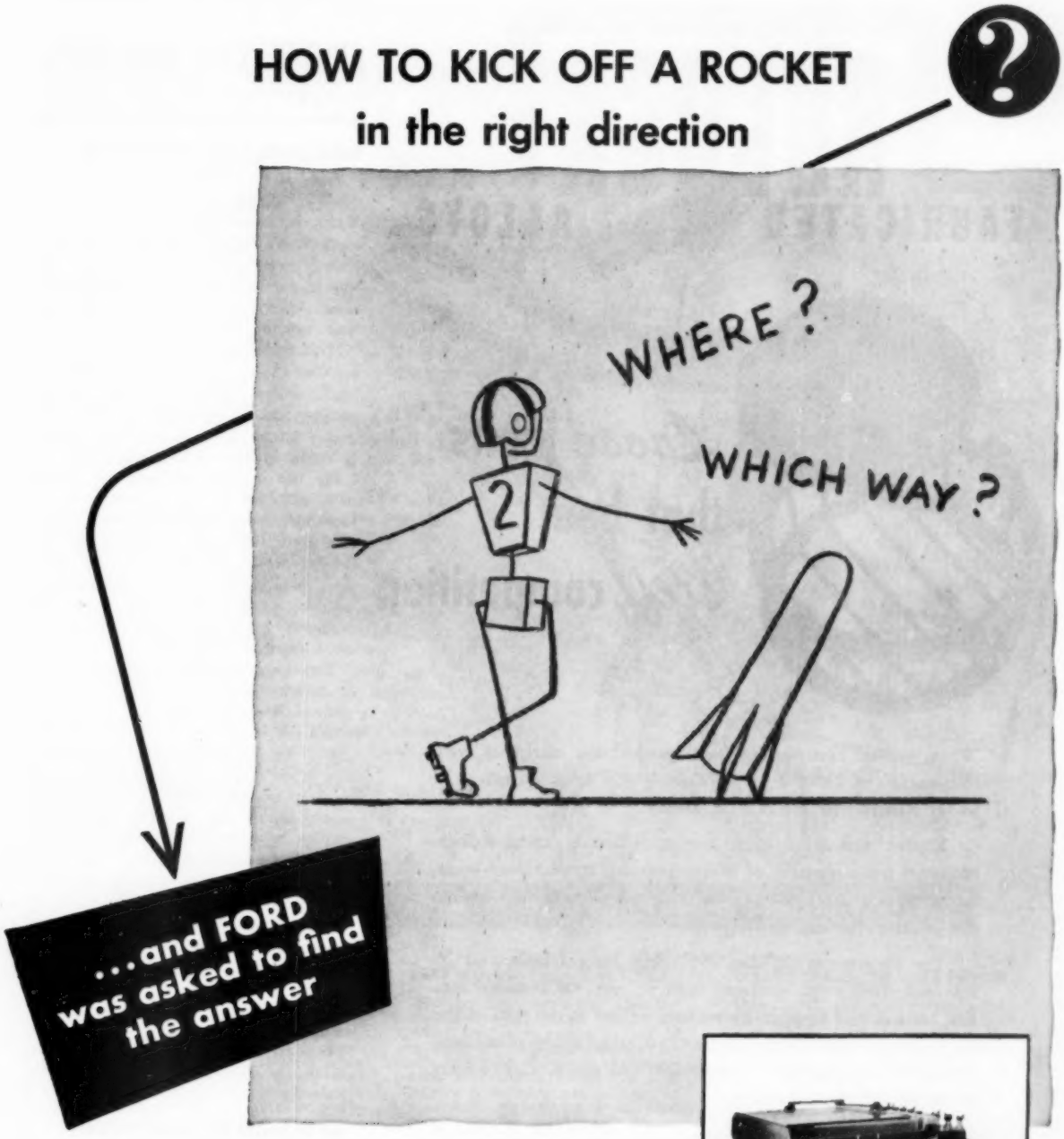
The foreword of the book itself contains the following: "With gratitude to those very early gun collectors—E. Berkley Bowie, C. L. Quick, and L. D. Satterlee," these being the chief contributors to Steuart's vast store of knowledge and whom he quoted verbatim in some instances in "Firearms of the Confederacy." I know because, as I say, I have all of his correspondence dealing with arms.

I am more than slightly confused by Colonel Goddard's direct charge of failure to give credit. Who was it I forgot to name?

WILLIAM A. ALBAUGH, III

Midlothian, Va.

HOW TO KICK OFF A ROCKET
in the right direction



Load! Aim! Launch! And off goes a rocket from shipboard . . . but not without precise devices that start the rocket in the right direction. Devices . . . such as Ford Instrument has manufactured for the Armed Forces since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic, electro-mechanical, magnetic and electronic instruments that bring us our "tomorrows" today. Control problems of both Industry and the Military are Ford specialties.

14

You can see why a job with Ford Instrument offers young engineers a challenge. If you can qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.

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In this instance, a large auto manufacturer asked Rolock engineers for a quantity of basket assemblies that would withstand the heat and shock of Mar tempering auto parts . . . with the greatest resistance to warping.

The answer was 18"-dia., 7½" deep Inconel baskets of 26 lbs. each. They were fabricated from ½"-dia. rod threaded thru flat bar and held in place by washers welded to the ends of the bar to form a loose jointed carrier . . . to take expansion and contraction without damage. A 4-mesh .080 wire disc is placed loosely in the bottom of the baskets.

There are many similar operations where loose joints will greatly extend basket life, reducing hourly costs . . . reflected in competitive quotations. Put us on the spot for solving heat-treating problems. We like it!

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FROM THE RECORD

THE DEMANDS OF PEACE

Peace for America demands these things: First, a defense of the Nation strong enough to impress upon any would-be aggressor the folly of attack and, secondly, an economy strong enough not only to sustain such a defense but also to allow Americans to enjoy the fruits of their own toil and genius.

Military defense means much more than a matter of size and numbers. Certainly it begins with a readiness to spend and to sacrifice whatever is necessary—and, I repeat, whatever is necessary—for a logical, ordered, and balanced defense program.

But this is only the beginning. What must be sought is this: the finding of the ideal middle way between extremes which, on the one side, would stupidly cheat our defenses to save money, and, on the other side, would amass weapons and strength with an abandon that would wreck our economy—and hence our Nation—without a gun ever being fired.

This is not merely economic sense. This is military sense, and, best of all, it's common sense.

We live in an age witnessing a revolution in the technique of arms and armies, and in the creation and production of all weapons for defense. In such an age there is one certain way to invite disaster—to commit a nation's whole resources and productive machine today to the abundant production of weapons that may be obsolete tomorrow.

In such an age, there is only one way to avoid disaster: to be ready for the danger of today while continuing to develop industrial power that can be swiftly directed to meet a newer and different danger tomorrow.—SECRETARY OF THE TREASURY S. M. HUMPHREY *in an address before the Union League Club, Philadelphia, Pa.*

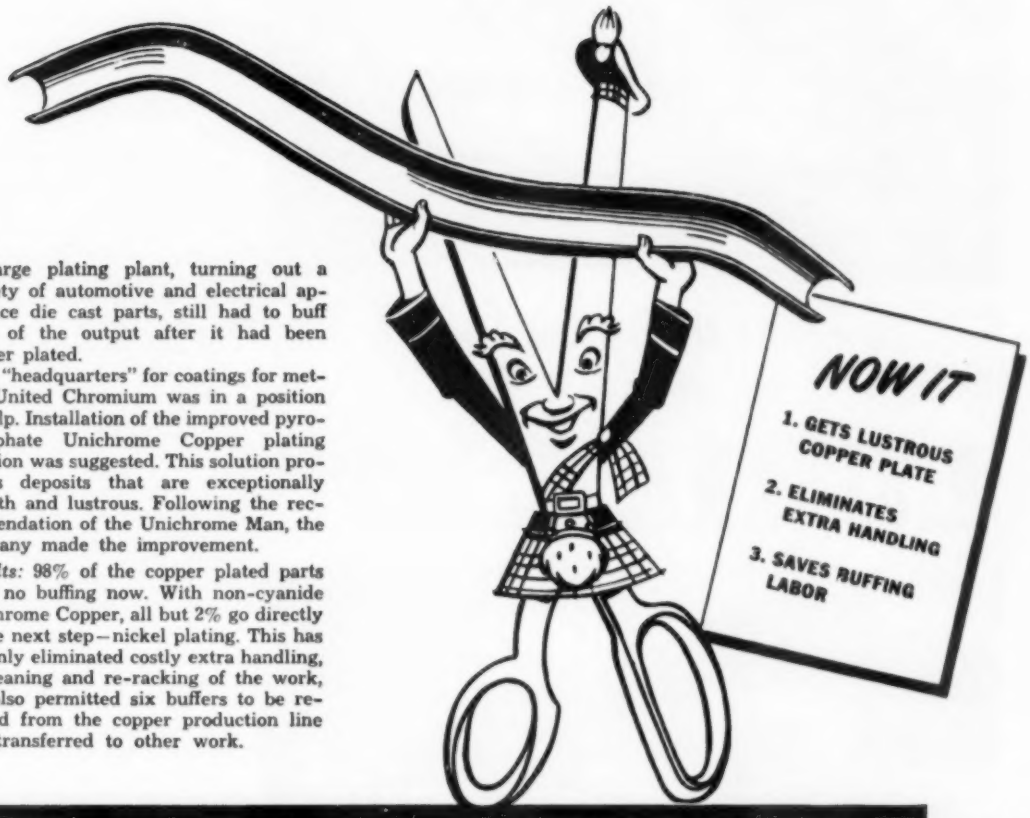
OUR MORAL STRENGTH

Freedom, like true peace, is never easily gained and once gained must be daily nourished and forever guarded. To maintain it, we must be strong. I do not mean merely the strength of numbers, or of weapons, important as these are. I am speaking rather of the strength which is most important of all—the strength of the human spirit—the moral fiber of a people dedicated to the cause of freedom.

Our Nation was built on that strength. Our forefathers placed freedom above all else and were willing to endure any adversity to achieve and preserve it. Those who lie on the green slopes of Arlington

MR. COST CUTTER SHOWS HOW

plating change cut copper polishing 95%



A large plating plant, turning out a variety of automotive and electrical appliance die cast parts, still had to buff 40% of the output after it had been copper plated.

As "headquarters" for coatings for metals, United Chromium was in a position to help. Installation of the improved pyrophosphate Unichrome Copper plating solution was suggested. This solution produces deposits that are exceptionally smooth and lustrous. Following the recommendation of the Unichrome Man, the company made the improvement.

Results: 98% of the copper plated parts need no buffing now. With non-cyanide Unichrome Copper, all but 2% go directly to the next step—nickel plating. This has not only eliminated costly extra handling, re-cleaning and re-racking of the work, but also permitted six buffers to be removed from the copper production line and transferred to other work.

MORE WAYS UNITED CHROMIUM HELPS CUT COST OF COATING METALS

Cuts corrosion costs

Reports show: Interior of brine tanks still protected 5 years after application of Ucilon* Protective Coatings; . . . 5 years' service also obtained against hydrochloric acid fumes with virtually no patchwork needed; even after 3 years, no failure seen in Ucilon Coatings on steel submerged in sewage. *Trade Mark

Save with the right zinc finish

With its electrolytic and chemical dip processes, United Chromium offers the most complete line of protective chromate finishes for zinc available. This wide choice results in substantial benefits because it means a finish not "almost as good as" but rather the one that best meets the user's needs.

Organic coating for extra service

When battling corrosive liquids and fumes, vinyl Unichrome Plastisol Compounds provide coatings so thick and tough, they can be depended on not to break down or wear through. They often permit economical use of ordinary metals in place of costly alloys.

TO FINISH IT BETTER AND SAVE

call in "The Unichrome Man"

UNICHROME

It pays to consult United Chromium on Metal Finishing Problems

United Chromium offers you the advantages of: (1) 25 years of specialized experience in metal finishing; (2) Wide experience in *both* organic and plated finishes; (3) A diversified line of products for decorative and functional finishing – including plating processes, protective coatings, chemical conversion coatings for zinc; (4) Thinking geared to *cost-cutting, product-improving* possibilities.

We'd welcome an opportunity to help you "Finish it better AND SAVE."

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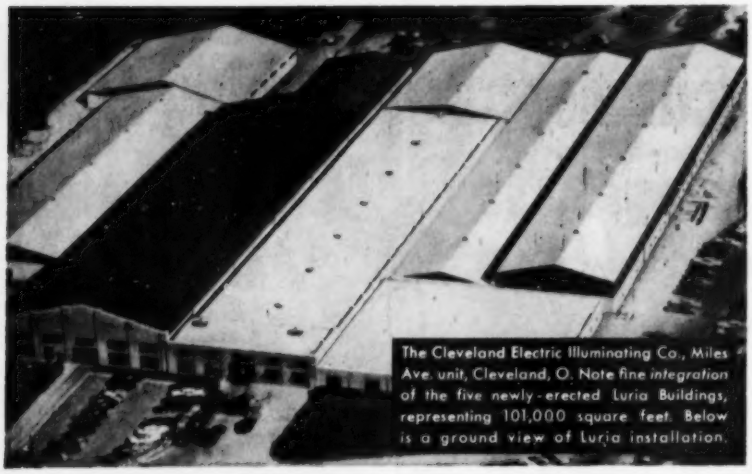

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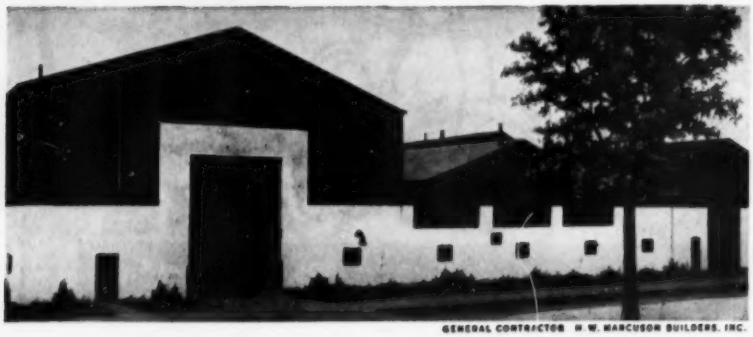

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helped perpetuate that heritage. For them, no sacrifice was too great. From Bunker Hill to Heartbreak Ridge they gave their lives that we might live in freedom.

Sometimes, however, there is a murmur of a phantom philosophy, one more of shadow than of substance. It is the illusory and dangerous idea that there is some easy way to make our freedom secure. It is a most appealing thought, but the grim fact is that security has never been attained without hardship and sacrifice.

There is no short cut to security. No weapon can be substituted for human faith, determination, and courage. In this age, more than ever before, security is a problem of all the people. No longer can most of the population remain safely at home while armies struggle for decision on distant battlefields.

In modern war, the front is everywhere. In any struggle of the future, more surely than in any struggle of the past, the moral strength of our people will finally determine the issue. The faith of our fathers must be ever with us.

Let us clearly understand then the choice before us. It is not between the productivity and contentment of peace on the one hand and the devastation and horror of war on the other. It is between strength and weakness, between freedom and slavery. When confronted with such a choice, there is no middle ground and there can be no compromise.

Those nations locked behind the Iron Curtain bear witness of the threat to the lives and liberty of free men everywhere. Through sad experience, we have come to know that Communism respects power alone. If the free world is to enjoy peace, then the free world must be morally and militarily strong enough to maintain it. —SECRETARY OF THE ARMY ROBERT T. STEVENS *in an address at Arlington National Cemetery, Arlington, Va.*

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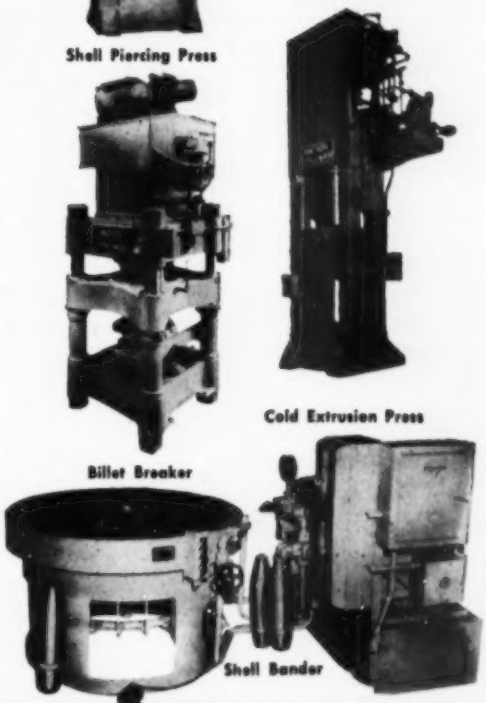

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From the Record

and security." Indeed, it may well be included in that objective.

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Fully automatic airline flight operations through electronic guidance and control equipment;

Reductions in the cost of air travel well below that of any other form of transportation.

These predictions are testimony to my faith in the conviction of all of us in aviation today that "the difficult we can do immediately—the impossible takes a little longer."

The only real problem we face in the second half-century of flight in America is the same one faced by the Wright brothers fifty years ago—to determine the scientific truths and to follow them with bold honesty through all difficulties to inevitable success.—GLENN L. MARTIN, *Glenn L. Martin Company, in a lecture before the Institute of the Aëronautical Sciences, Washington, D.C.*

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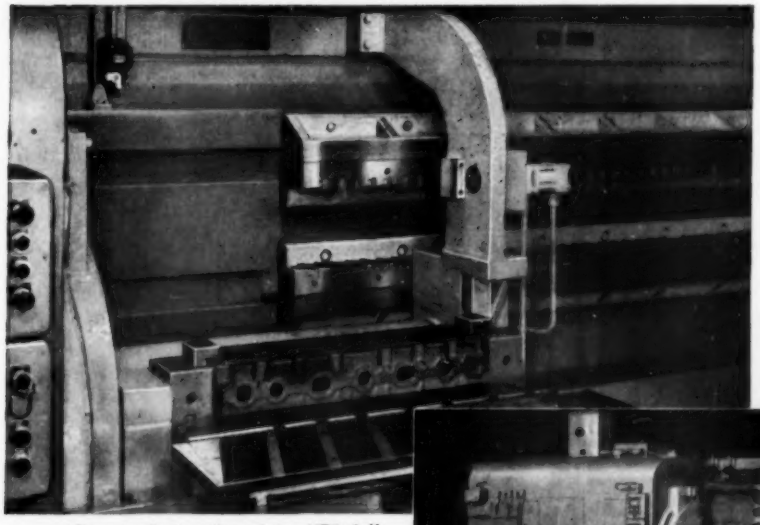

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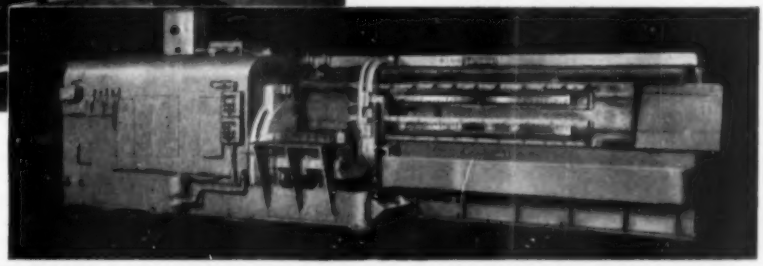

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(A letter from William A. Albaugh, III, concerning the review of his book, "The Original Confederate Colt," which appeared in the November-December 1953 issue of ORDNANCE *is published in the Communications section on page 808 of this issue.—*THE EDITORS.)

The Secret War for the A-Bomb. By Medford Evans. Chicago: Henry Regnery Company. 302 pp. $3.95.

THE author of this record of the betrayal of America's atomic secrets, our sadly muddled atomic policies, and our present vulnerable position, writes from the vantage point of an active participant in security work with the Atomic Energy Commission. He rounded out his eight years of service with AEC by a year's work as chief of training.

The keynote to Evans' book is his impressive documentation. Were it not so massive, well chosen, and thoroughly applied, the startling thesis of the author might well strike the average reader as incredible.

Boiled down, this thesis is simply that it is not at all improbable that the Soviets possess some twenty A-bombs (either assembled or ready to assemble) within the continental limits of the United States. Planted in key positions, they would be

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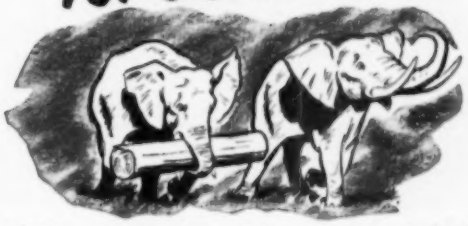

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Book Reviews

already "delivered" and simple to detonate whenever the fateful decision on all-out war was made.

In support of his startling theory, Evans very reasonably shows that the U.S.S.R. is quite incapable of producing the finished materials of atomic bombs in any real quantities. Then he shows the ease with which these materials could have been quietly stolen from our plants and laboratories, particularly Oak Ridge (preparation of U-235) and Los Alamos (finished materials).

We already know that small quantities of these products have actually been taken and recovered. In view of the author's well-informed exposition of the great difficulties of effective checks and of the gaps in security, it is well-nigh impossible to think that this recovered material represents all that was taken by hostile espionage rings, their willing helpers, and their dupes among well-meaning but naïve "liberals."

Much corrective procedure, both in moral and in practical fields is suggested. But the main purpose of this rather terrifying volume is simply to acquaint the thinking American reader with the startling implications and possibilities of today's atomic situation.—F. W. FOSTER GLEASON.

Nuclear Physics. By W. Heisenberg. New York: Philosophical Library. 225 pp. $0.75.

AS one of the most successful and distinguished physicists of our time, W. Heisenberg is particularly qualified to write about our knowledge of the atomic nucleus. The contents of the booklet, with the exception of the last chapter, are presented in the form of lectures to the Association of Electrical Engineers in 1941.

After an introduction dealing with atomic concepts of previous centuries, the structure of atoms and molecules is described briefly from a modern standpoint. The main part of the book is devoted to the energies and forces of nuclei and to their mutual reactions. Particular emphasis is put on the analogies and differences between the atom and the nucleus.

Basic principles, such as the duality of waves and particles, or the uncertainty principle, are explained without resort to higher mathematics. The binding energy of a nucleus is interpreted as the sum of three components. The first results from the nuclear forces (exchange forces), the second from repulsive forces between protons, and the third from the modification of these forces by surface tension.

Artificial transmutation of nuclei, which frequently results in radioactive isotopes, is described in various examples. The tools for nuclear research from the Geiger counter to the giant atom smashers are enumerated in one paragraph. A long chapter deals with the application of nuclear physics to biological, chemical, medical, and engineering research and to the large-scale production of power in nuclear reactors. Structure and functioning of uranium piles are described.

The book is illustrated with forty sketches, diagrams, and photographs. Several tables present atomic and nuclear data. The mathematics do not extend beyond a few arithmetical equations. The book is written mainly for readers who are not trained in nuclear physics but who want to become familiar with the problems, difficulties, and achievements in this field of research and with its relationship to other branches of science. The book will also be highly appreciated by students of nuclear physics who desire a concise, easily understandable introduction into their subject.—ERNST STUHLINGER, *chief, research section, Guidance Control Laboratory, Guided Missile Development Division, Redstone Arsenal, Huntsville, Ala.*

Judge Medina. By Hawthorne Daniel. New York: Wilfred Funk, Inc. 316 pp. $4.

THROUGHOUT this excellent and lucid biography two of Judge Medina's characteristics repeatedly emerge: his indus-

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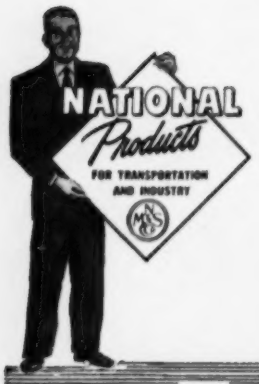

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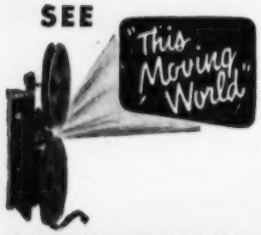

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triousness and his thoroughness. Despite his early struggles and disappointments as a boy, as a Princeton undergraduate, and as a law student at Columbia, the judge learned the paramount value of hard work and concentration. These are the principles by which his life has been guided.

Another aspect of his early and middle years is, in this reader's opinion, significant. He exposed himself with serious enthusiasm to French and English literature and to Greek and Latin classics with the consequence that his eventually became an uncommonly rich and generous spirit.

Judge Medina, as this biography shows, has continuously and with immense success practiced what in military terminology is known as prior and concurrent planning—no halfway measures or methods for him. However unimportant or unremunerative the problem or mission he was given, he approached it with the same care as he did the famed trial of the eleven Communists in 1949.

Judge Medina is a patriot of classic proportions. This the whole world learned during his wise and patient handling of the 1949 trial. Not so well remembered was his successful defense (without fee) of Anthony Cramer, an impoverished German-born American accused of treason in 1942, the darkest year of the war for us.

Unhesitatingly Medina accepted this task in order "to demonstrate both to our people and to the world that such a man can have as good a defense under our system as if he were rich."

This is a book which could be read to advantage in every American home, for it is the story of a noble American, a true patriot, a born leader. Perhaps Judge Medina's greatest contributions to us all are his deep belief in our country and his unflagging faith in personal integrity and morality.—JOHN C. NEFF, *G-2, 77th Organized Reserve Division.*

Unconditional Hatred. By Capt. Russell Grenfell, R. N. New York: Devin-Adair Company. 269 pp. $3.75.

IT has become so commonplace to blame Germany for all the wars and rumors of wars which have beset mankind during the last century and a half that it is refreshing to find a British sea dog (and an unusually articulate one) who disputes this theory—and with figures that appear irrefutable. Thus, for the period 1815-1907, he credits Britain with ten wars, Russia seven, France five, Austria three, and Prussia-Germany, three.

Blame for the First World War he attributes (quoting in turn three distinguished writers, one British, one American, and one French) to Serbia, Russia, and France, in that order. The commitment of Britain to participation in that

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holocaust, one in which he maintains she properly had no part, he ascribes to a casual suggestion in January 1906 by Sir Edward Grey, Foreign Secretary, to Mr. Haldane, Secretary of State for War. Grey asked Haldane to initiate exchanges between the British and French General Staffs looking toward a concert of operations in the event of war in Europe, and Haldane agreed to do so.

"The million men who were later to be killed as a result of this . . . conversation could not have been condemned to death in more haphazard a fashion."

Comes World War II. Again, holds Grenfell, it was an insensate act for Britain to guarantee Poland's integrity, and thus she found herself once more embroiled in an affair not properly hers and destined eventually to bring her close to utter ruin. As to responsibility, Grenfell points out that Germany had as much right to the Polish Corridor as had France to Alsace-Lorraine.

But this the two crusaders, Churchill and Roosevelt, disdained to consider. Instead they delineated Germany as a sort of two-headed monster, conceived in and dedicated to iniquity. Their only object became the destruction of "the twin roots of all our evils, Nazi tyrrany and Prussian militarism. . . ."

But it would seem that neither Churchill nor Roosevelt was capable of seeing beyond the end of his own nose. Crush Nazism and Prussianism they did. But what was their plan for a postwar Europe? Apparently none. Within five years, despised and defeated Germany was being urged to rearm—to protect Britain and America against an erstwhile ally! What, then, did it avail to destroy her in the first place?

For this, the good captain's answer is obvious: To wit, that when politicians become crusaders they are very likely to sow the wind and reap the whirlwind. Whether one agrees with him or not, he writes entertainingly, forcefully, and, to me, convincingly. This is an important book. I salute the captain for a grand job. —CALVIN GODDARD.

Economics of National Security. Second Edition. By George A. Lincoln. New York: Prentice-Hall, Inc. 643 pp. $6.75.

THIS second edition of "Economics of National Security" is a complete revision of the 1950 edition. The book is divided into four principal parts. The first section gives the history and description of the problem, with considerable emphasis on government. The second section describes the resources which produce military power and discusses their management on a plateau of preparedness and in an emergency.

American Ordnance Association

BOOK SERVICE

Book of the Month for March

THE ATOMIC SUBMARINE AND ADMIRAL RICKOVER

By Clay Blair, Jr.

The amazing story of the world's first nuclear-fueled submarine and the indomitable man who built it. The controversial account of Rickover's fight for his own and his boat's success, may be questioned for years. But the NAUTILUS is fact—a true submersible with globe-circling range. She puts America immensely ahead in the research required for eventual use of atomic power for both peace and war. Retail, $3.50. To Members, $3.15.

TOMORROW'S AIR AGE

By Holmes Alexander

An excellent portrayal of the impact of the air age in the immediate and foreseeable future. Written for the layman, but interesting reading for all. Retail, $3.00. To Members, $2.70.

The Original Confederate Colt

By William A. Albaugh III and Richard D. Steuart

A 62-page research study on Confederate firearms, especially the Leech & Rigdon and Rigdon Ansley revolvers. Mr. Albaugh, using collaborative data from the late Richard D. Steuart, fortified by his own experience and scholarship, has produced an especially worth-while contribution to the history of American arms. Retail, $5.00. To Members, $4.50.

UNITED STATES DESTROYER OPERATIONS IN WORLD WAR II

By Theodore Roscoe

Technical Research by Rear Adm. Thomas L. Wattles

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U.S. Army in World War II
The War in the Pacific

By Louis Morton

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By Philip Wylie

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Book Reviews

The third section treats of finance and economic stabilization under emergency conditions, and the fourth and final section deals with international aspects and the effect of these aspects on our way of life.

This book is concerned with managing America's resources for defense and is so subtitled. The author and his associates have written as individuals and have presented personal views on some controversial subjects but have, at the same time, indicated enough of the counterarguments to provide a basis for individual conclusions.

The primary objective of the book, as set forth by its author, is to make the reader aware of certain important problems of national security and the cost thereof, both in money and in measures affecting the lives and livelihood of the individual.

The main weakness of this work is that it covers too much in too few pages, but this may constitute a recommendation to busy individuals. There are other books which give more space to such matters as stabilization controls, but they are particularly out of date on the continuing problem of high military expenditures. This book is likely to be the only one looking "across the board" for some time.—JOHN D. BILLINGSLEY.

Scientific Research and Development in American Industry —A Study of Manpower and Costs. U. S. Department of Labor, Bureau of Labor Statistics and Department of Defense. Washington: U. S. Government Printing Office. 106 pp. $0.50.

THIS review of research and development in industry was based on a comprehensive survey of nearly 2,000 companies with about 6.5 million employees and represents a good cross section of American industry.

Since the survey reflects the effects of the Korean war, it might be of interest to both Government and industry planners and educators in pointing out the areas which, from a manpower standpoint, might prove to be critical in any all-out war.

It is believed that this reference booklet should also prove of interest to Government research and development and procurement personnel in assisting them in evaluating potential research and development contractors.—S. M. SMOLENSKY.

Beyond Containment. By William Henry Chamberlin. Chicago: Henry Regnery Company. 406 pp. $5.

THE author of this book has presented as impartial a picture as is probably possible of a subject that is still unfinished current history. He not only gives a clear account of our hapless dealings with the Soviet rulers since 1941 but goes back to show that the historical record of a long diplomatic history should have alerted our officials to the impossibility of making treaties with a government that does not recognize moral standards.

Deceit and treachery in international relations and contempt for its own people had long been the characteristics of the Czarist Government, and the Soviet leaders continued that policy on an even more audacious scale and for a more diabolic purpose.

During the Russo-Japanese War the United States got the Russian Government off the hook by a forced peace that saved it from revolution. But that government did nothing to better the position of its people or to improve international relations.

Secretary of State John Hay said at that time: "Russia's vows are as false as dicers' oaths when treachery is possible." And President Theodore Roosevelt said: "Her (Russia's) diplomatists lied to us with brazen and contemptuous effrontery."

In spite of the record we treated in almost childish simplicity with Soviet leaders whose promises had never been kept, and our diplomats bargained with these characters, not at the command of the American people, but without letting the people know what was going on.

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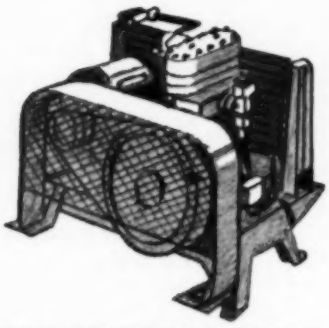

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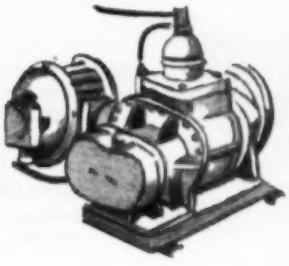

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Book Reviews

After 1941 the American public was flooded with propaganda about "our gallant democratic ally" without a word of the brazen effrontery of the Soviet demands. It is inconceivable that the Congress or the people would have consented to the Yalta Agreement, which the Administration accepted as a solemn treaty, if they had been told the plain facts about it, especially the endorsement by the United States of the principle of human slavery, one feature of which was bartering Christian Poland to the godless slave state and another allowing Soviet use of German prisoner labor as a source of reparations.

It is a long and harrowing story that is told in this book, down through our bewildered handling of China, through the statements of our officials which gave the Kremlin the impression that the time had come to take over Korea for a march on Japan, to recent days when we haggled with the Communists over non-Communist prisoners to whom we had promised freedom if they would surrender to us.

Churchill made strong efforts to impress on our officials at Potsdam the dire consequences of the suicidal policy of snatching at every diplomatic bait of the Communists, and he begged that the American Army not be withdrawn but be kept at full strength at the extreme advance until the Russians had fulfilled their promises. The author of this book does not advance his own opinions, he lets events speak for themselves.

After a brilliant analysis of the whole background the author fails to give the answer expected by the title of the book, "Beyond Containment." There is an implication that the policy of keeping the Communist empire within its present boundaries is not peace and cannot be peace. Its cost, measured in dollars, is as great as a perpetual major war. After documentary proof that the Soviet Government has not changed its policy of determination to destroy all spiritual and political freedom in the world, it is left to the reader to judge whether the hundreds of millions of people who have been enslaved by the Soviet machine will ever be delivered by anything but force.

None of the political problems of the international situation have an answer in the book. Only one thing becomes evident —whether democracy itself can continue to exist under a system of diplomatic secrecy.

It is apparent from the words of the Soviet leaders themselves that they feel that they can attain their ends without a fighting war—that the continual drain on the resources of the Western nations will bring the continuing compromises which will attain the ends.—GEORGE S. BRADY.

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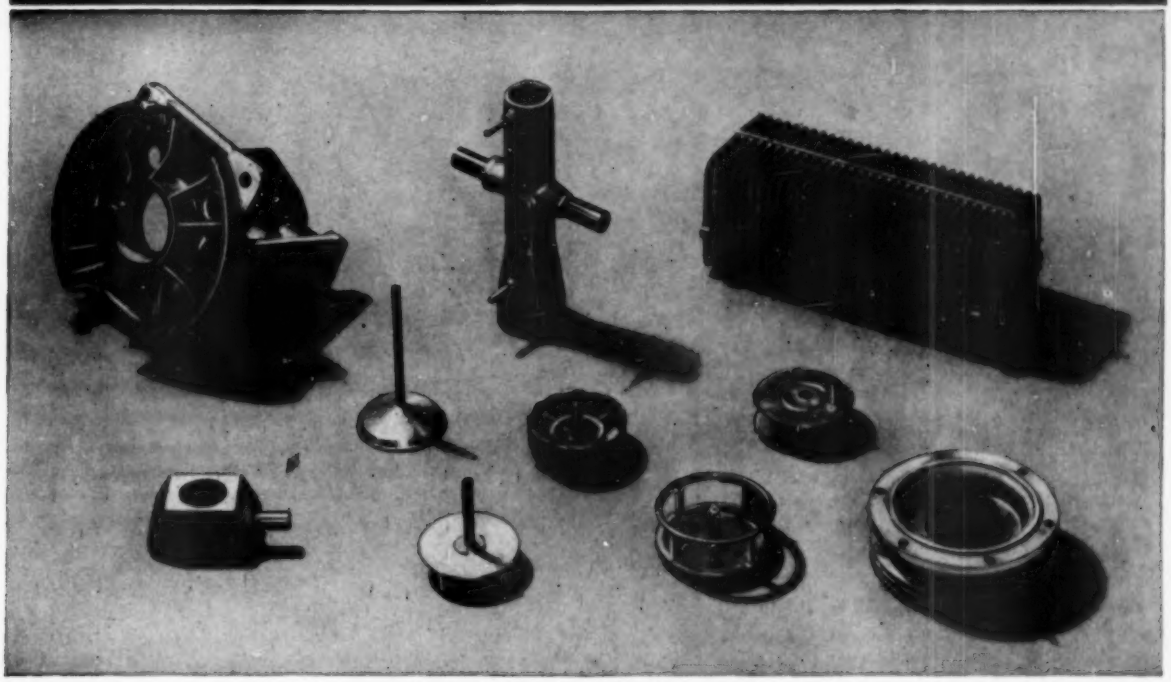

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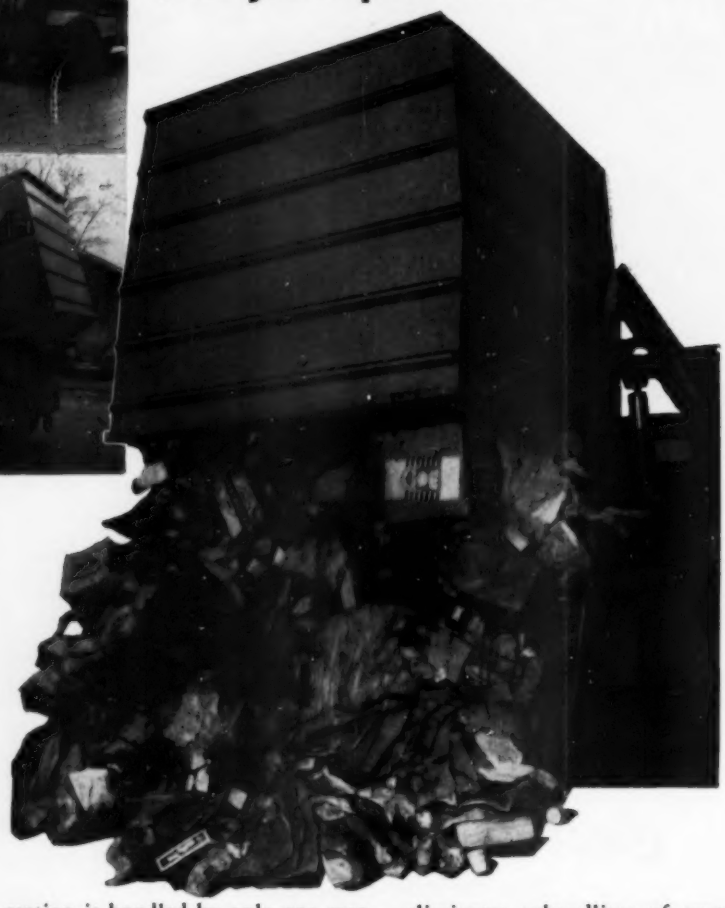

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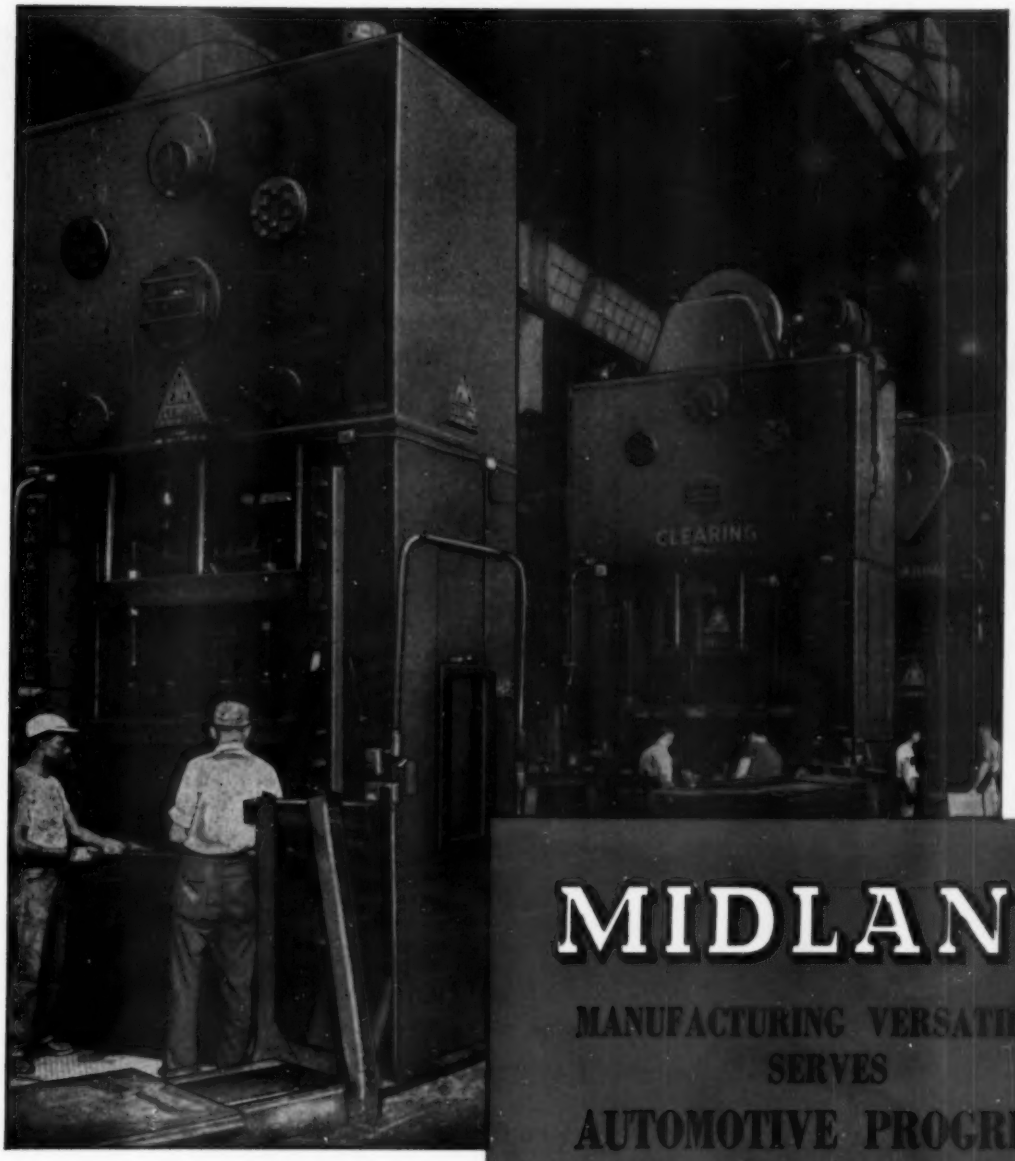

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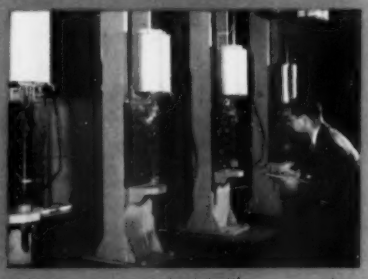

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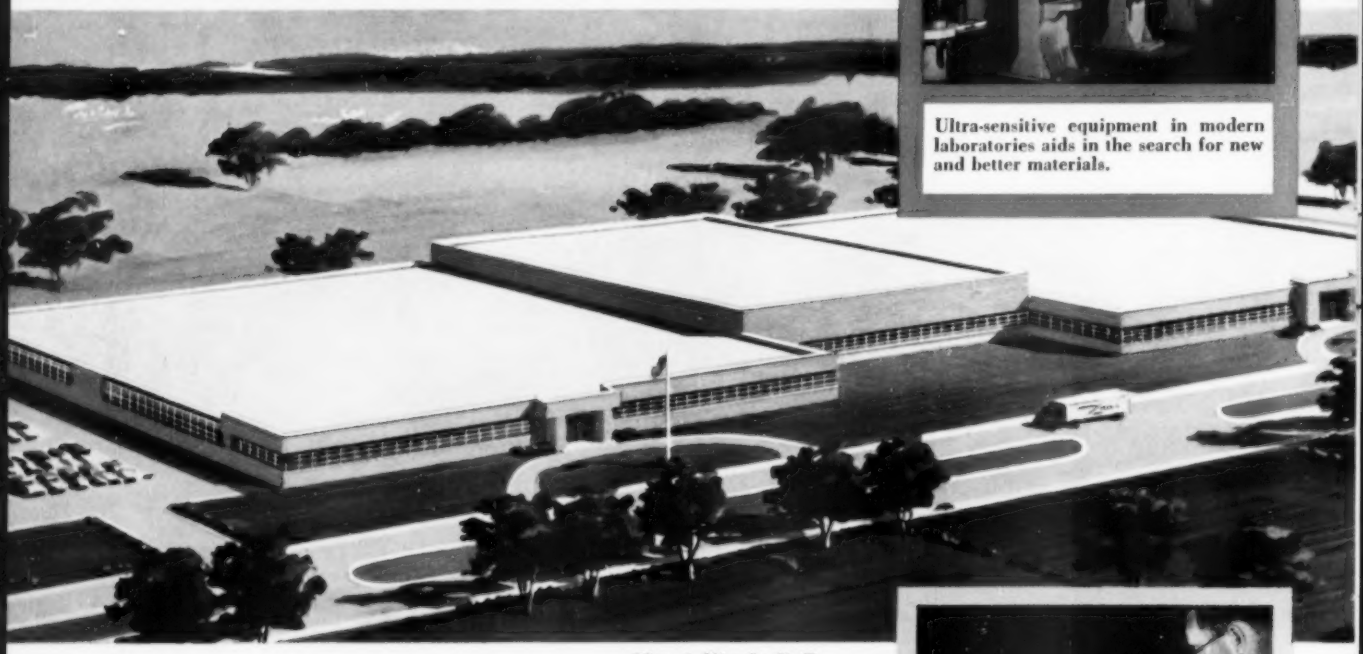

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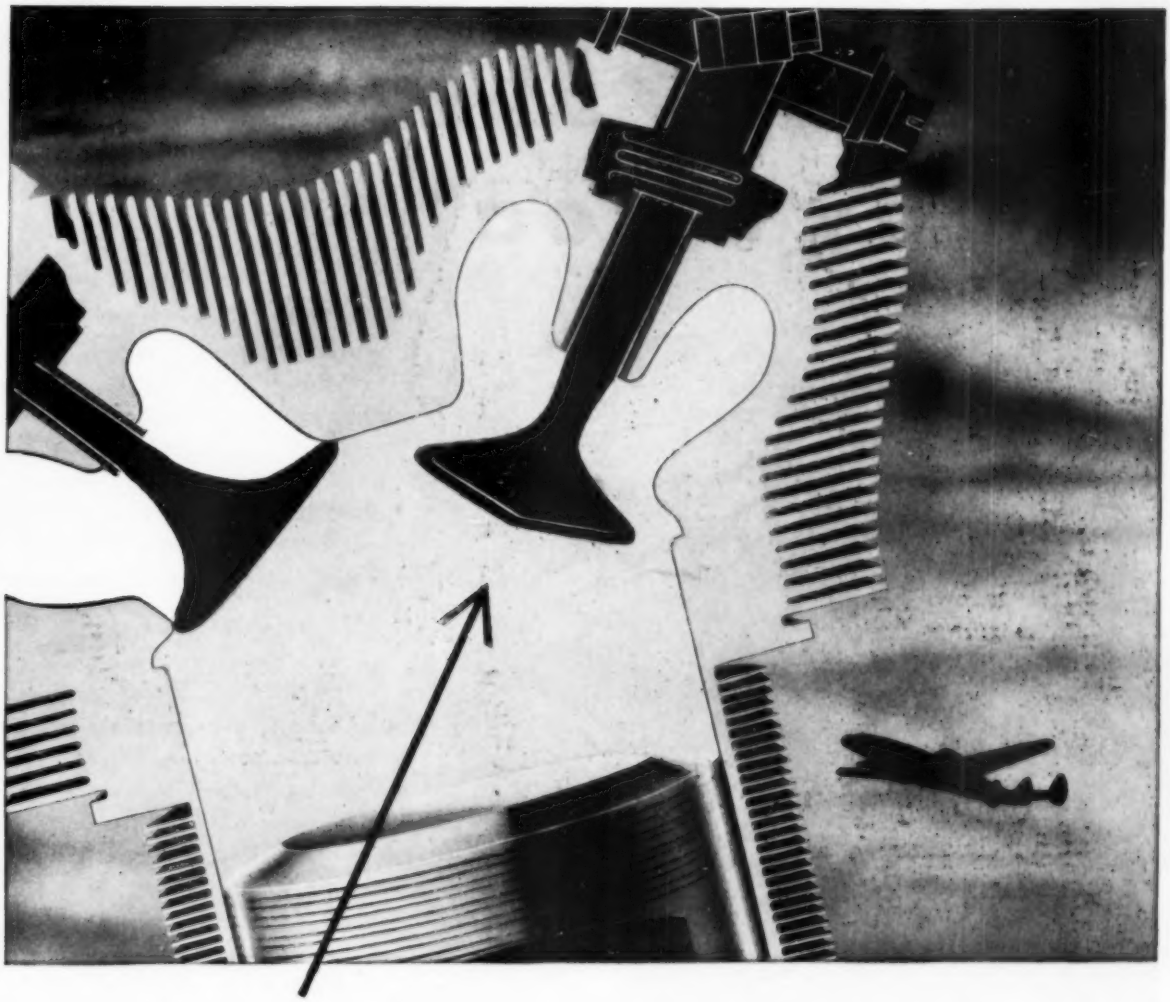

This valve is a Spendthrift

But it needn't be! Valve clearance trouble, with resulting fuel and power waste, is easily detected by the Sperry Engine Analyzer. By using vibration analysis to check each cylinder under normal operating conditions, valve clearances can be adjusted for smoother engine performance. Result . . . engines develop full power—run cooler—use less fuel—last longer.

Vibration analysis, exclusive with the Sperry Engine Analyzer, can be employed either in flight or on the ground. When using the Engine Analyzer, valve clearance can be easily checked at each inspection and overhaul—a profitable procedure for airlines and executive aircraft operators.

In addition to vibration analysis, the Sperry Engine Analyzer also provides detailed ignition analysis. It immediately detects, locates and identifies irregularities in aircraft power plants—either during flight or on the ground. Aside from saving ground maintenance time, the Engine Analyzer enables the flight engineer to maintain proper operating conditions at all times and prevents unnecessary component replacements.

Our nearest district office will give you complete data upon request.

SPERRY PORTABLE ENGINE ANALYZER

ENGINE ANALYZER IS MANUFACTURED AND LICENSED UNDER JOHN E. LINDBERG, JR. PAT. NO. 2510427. OTHER U.S. AND FOREIGN PATENTS PENDING.

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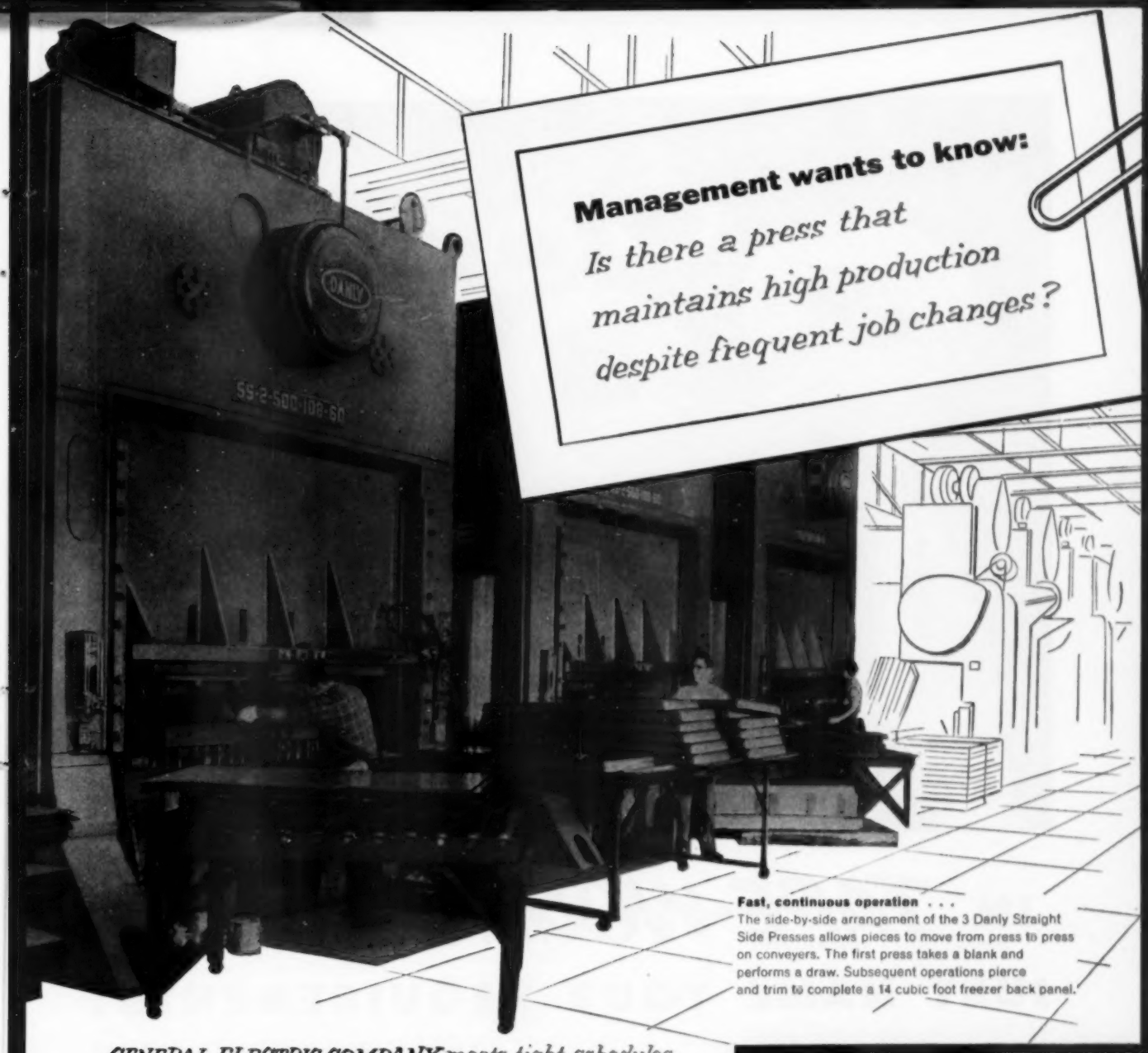

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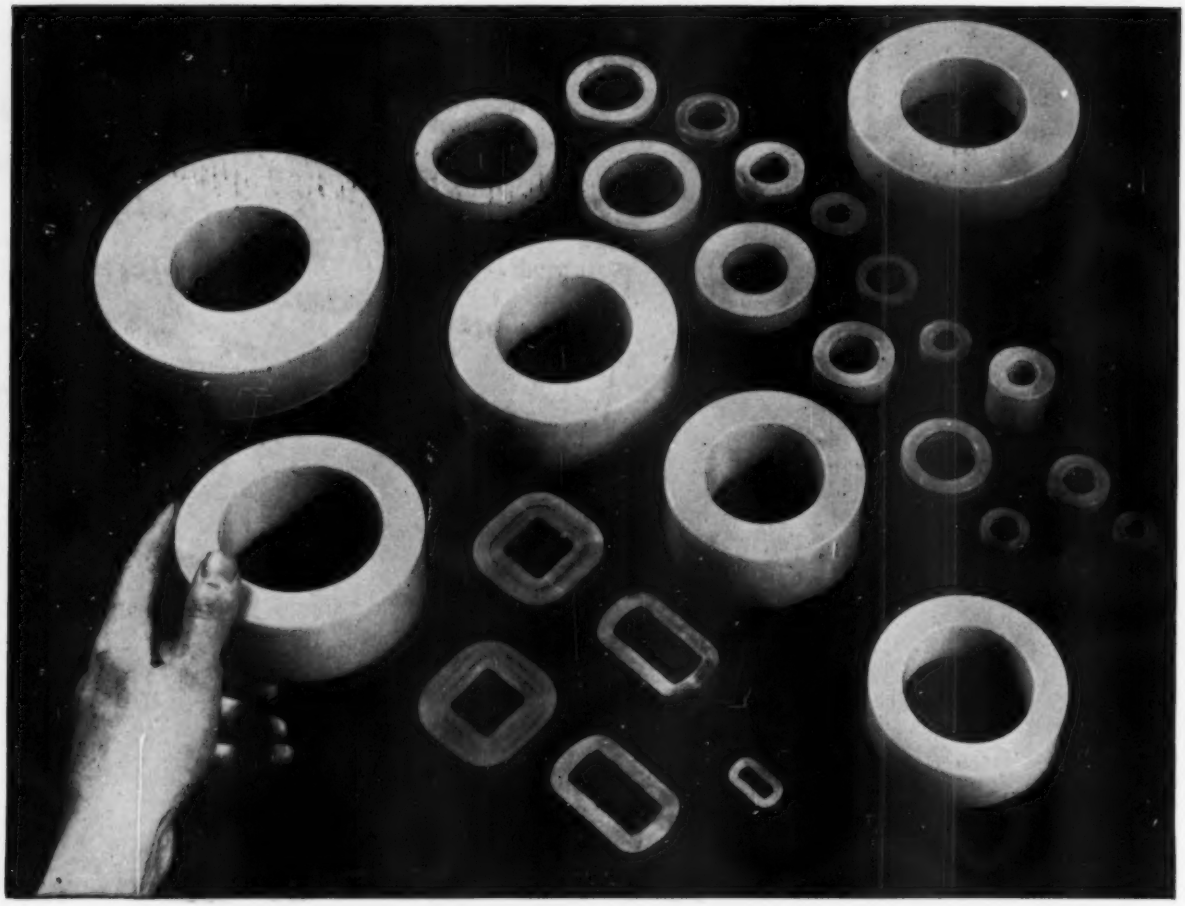

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Previously, the personnel record for each employee of this company (Union Bag and Paper Corporation) consisted of an ordinary file folder into which papers were placed. In the event of a job change, rate change, credit or other reference, contents of the folder were leafed through until the proper sheet was found . . . and more often than not its contents completely disarranged!

Classifile Personnel Folders equipped with Kompakt fasteners, one on each side at opposite ends, lock all papers in position.

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All personnel folders at Union Bag & Paper Corporation are housed in Remington Rand *certified* insulated Safe-Files . . . and all Kardex personnel records are housed in *certified* insulated Safe-Kardex. This equipment assures protection from the ravages of fire. Let us show you why more companies everywhere are finding such protection pays, and are turning to *certified* insulated equipment for personnel records.

Get the full story, "How Remington Rand Systems Simplified Personnel Records at the Union Bag & Paper Corp. of Savannah, Ga." Circle **CR906.**

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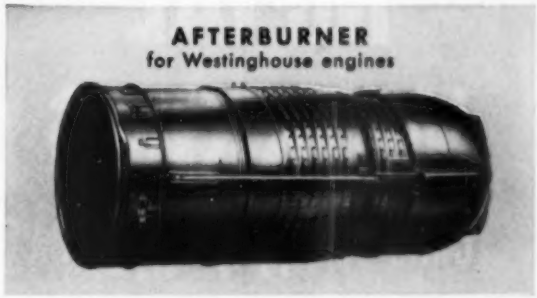

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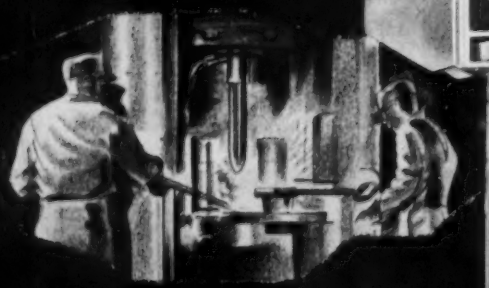

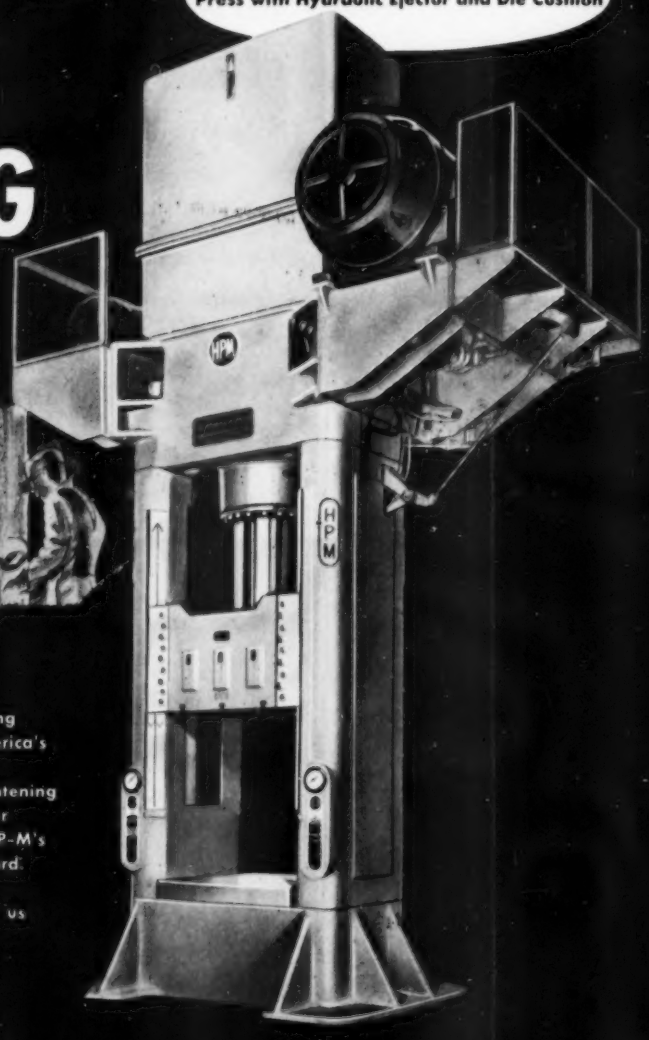

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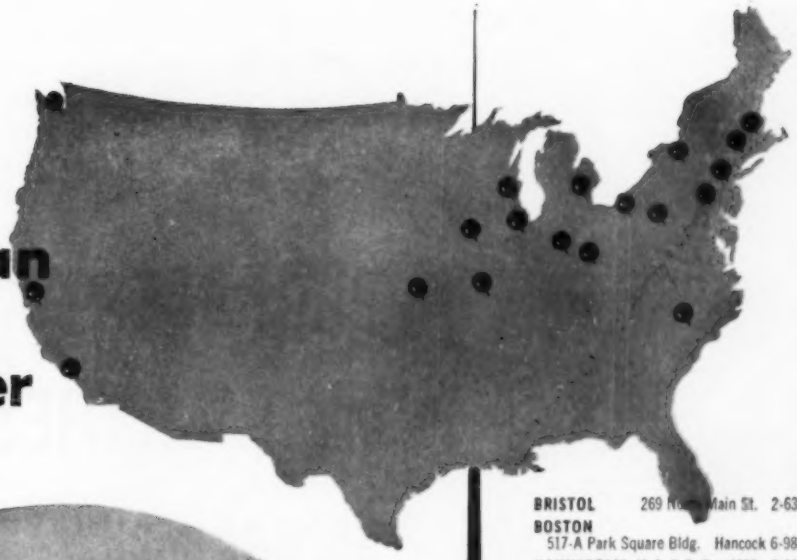

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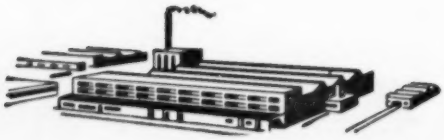

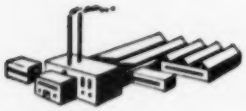

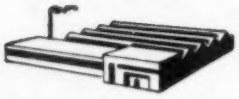

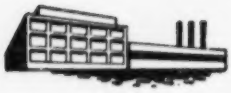

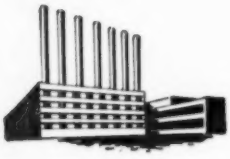

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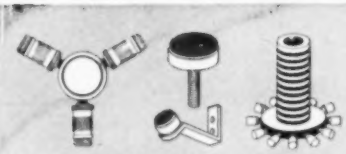

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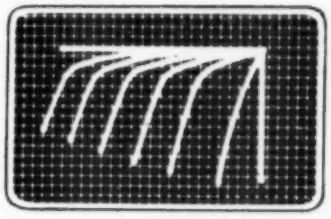

Presents on the Scope:

Alpha vs. Emitter Current

•

Collector, Emitter and Transfer Characteristics

•

Collector Characteristics in Grounded Emitter Connection

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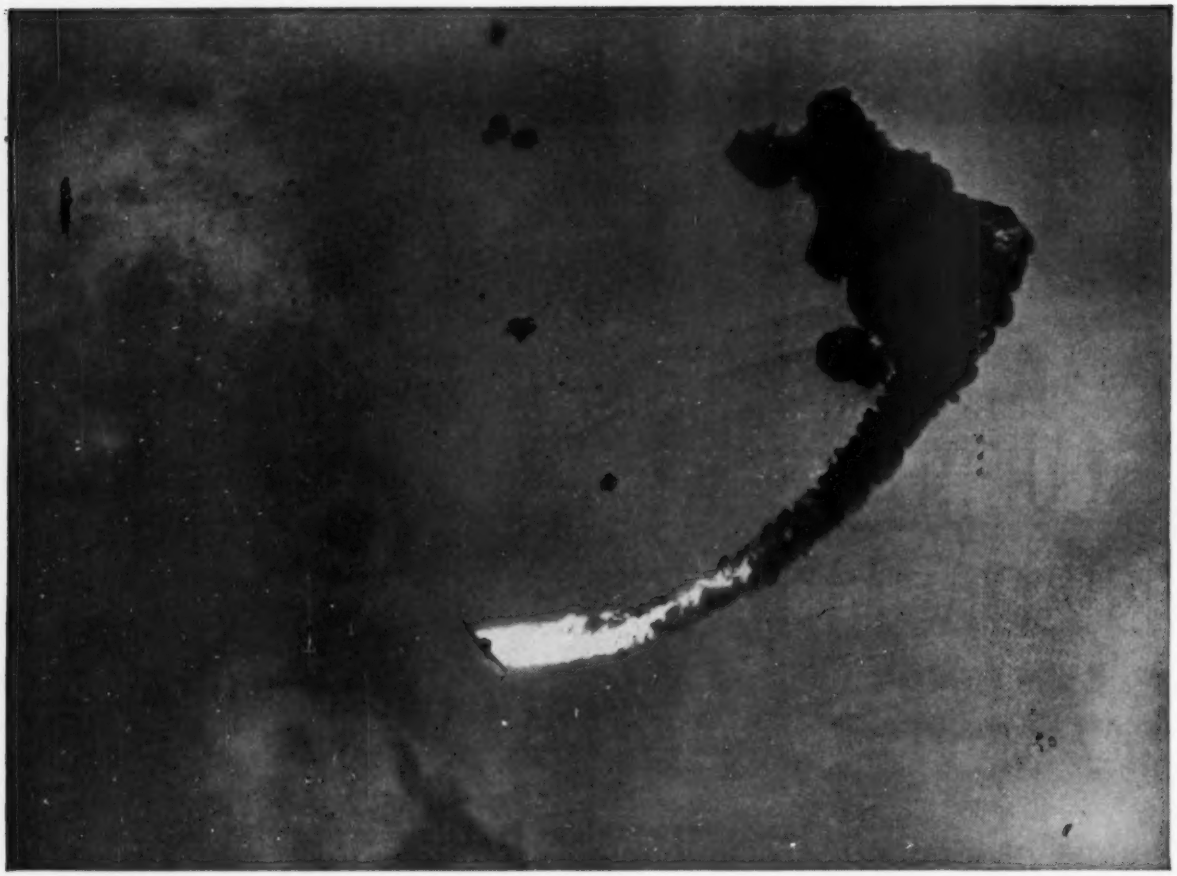
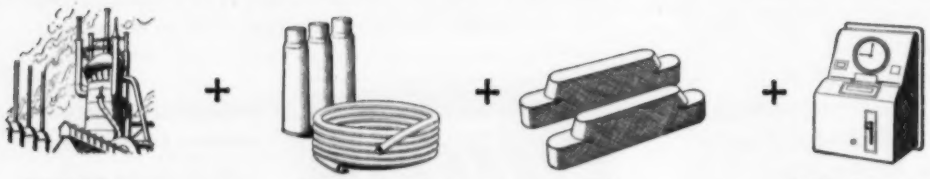


What it takes to pick off a "bird of destruction"!



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Copper and Brass
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Nickel
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Machine Operation
30,000 hours

All these elements add up to just one anti-aircraft unit! An aircraft carrier requires a battery of 20 to provide the principal protective cover from air attack.

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This is only one example of the job American industry is doing to insure effective military preparedness. Only by producing better products faster through individual *speed* and *skill* can we keep our nation militarily alert.

Above figures given with due regard for security.

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the BENDIX IGNITION ANALYZER

the only way to make a COMPLETE, POSITIVE, DYNAMIC check of the ENTIRE Ignition System . . . without removing the engine

tanks in action not in repair depots

Preventative maintenance is vital to the success of tanks or armored vehicles on the field of battle.

Fortunately in the case of ignition systems, incipient failure or intermittent malfunctions can be spotted immediately with the Bendix Ignition Analyzer. This provides *real* preventative maintenance.

The Bendix Ignition Analyzer gives a dynamic test of the entire ignition system in operation, outmoding time-consuming static testing of individual components. It is the easiest (checks the entire ignition system in the *field*) and the fastest (locates *any* ignition fault immediately) method of preventative maintenance ever devised for checking ignition efficiency in military vehicles of all types.

Descriptive folder available on request.

Here's How It Works —

The Bendix Ignition Analyzer provides a visual picture of the *actual* voltage waveform patterns occuring at the spark plugs. Normal ignition produces a characteristic normal waveform pattern. Likewise *any* abnormal ignition condition will produce its characteristic abnormal pattern. Interpretation of the patterns identifies and locates any ignition troubles immediately.

Bendix

The Bendix Ignition Analyzer safeguards ignition systems in all types of military equipment.

SCINTILLA DIVISION OF Bendix AVIATION CORPORATION
SIDNEY, NEW YORK

Export Sales: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

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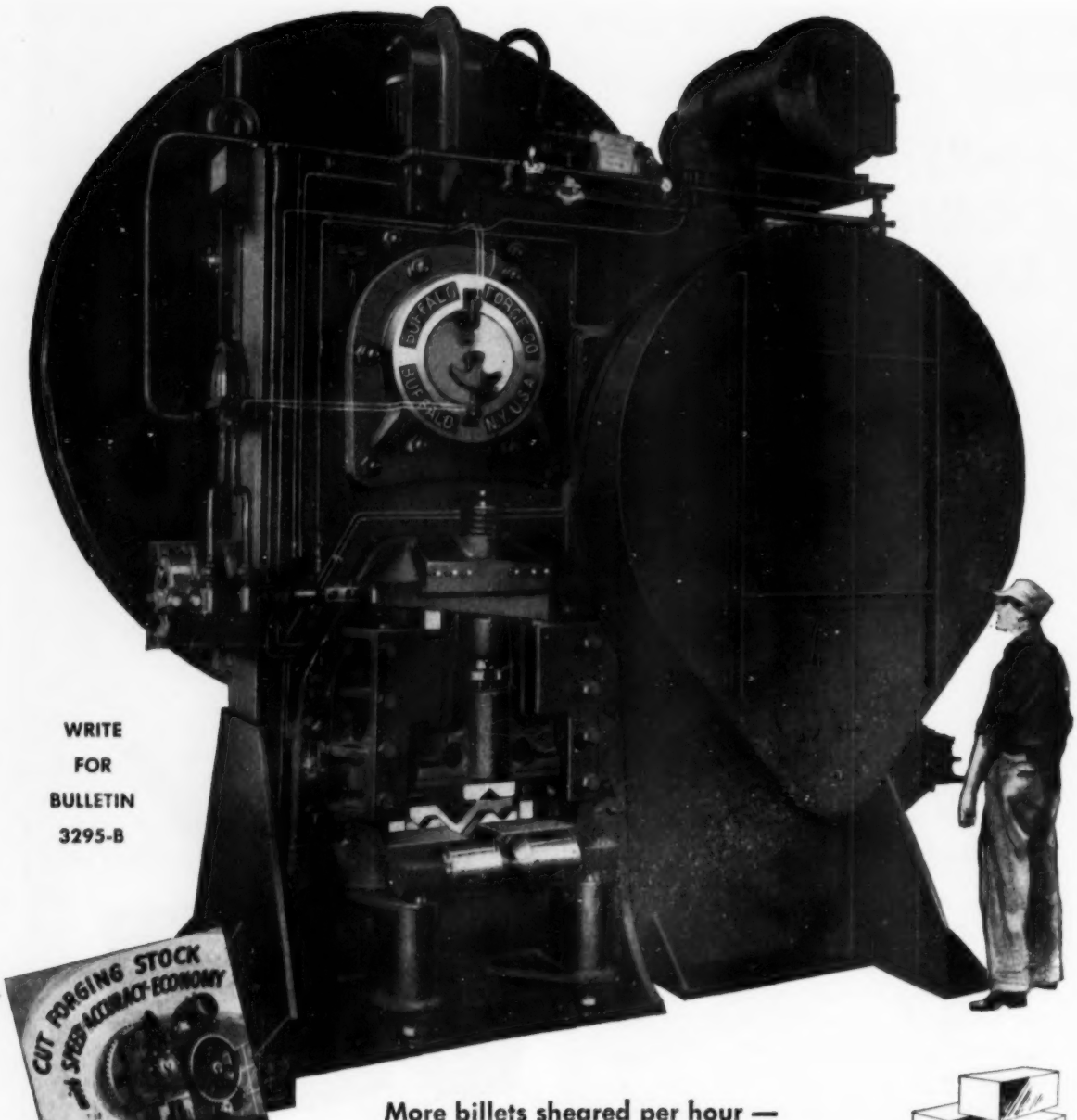

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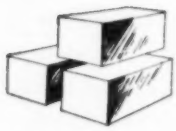

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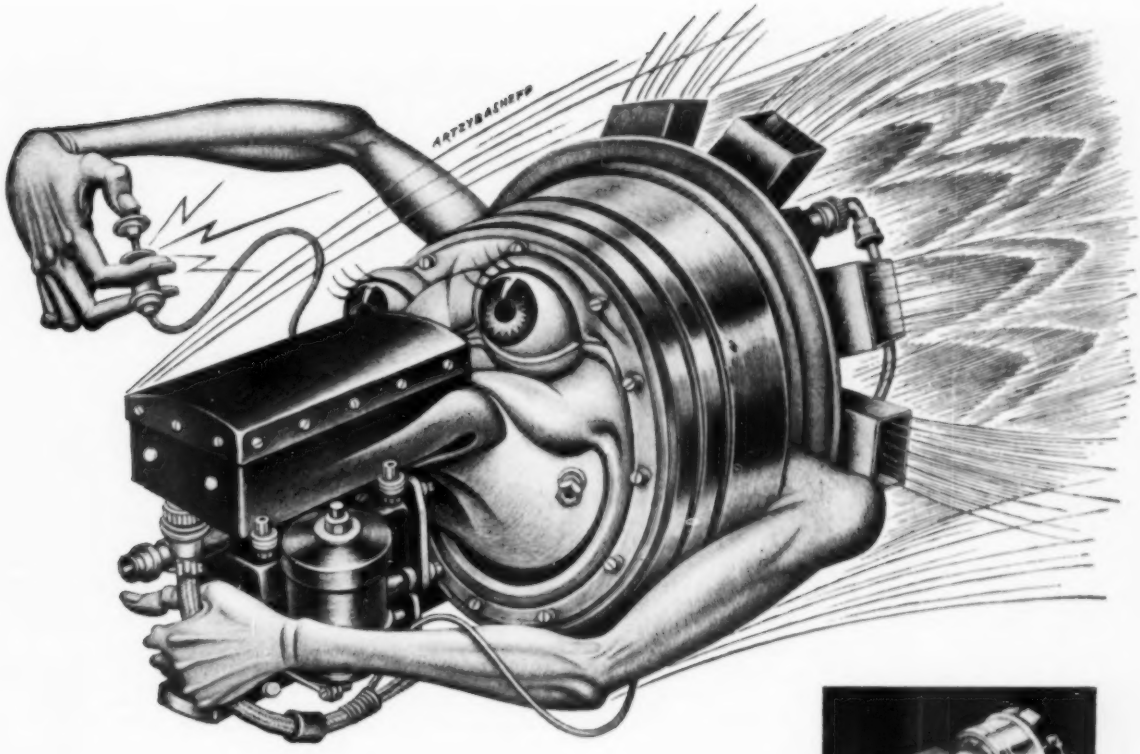

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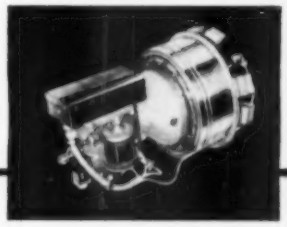

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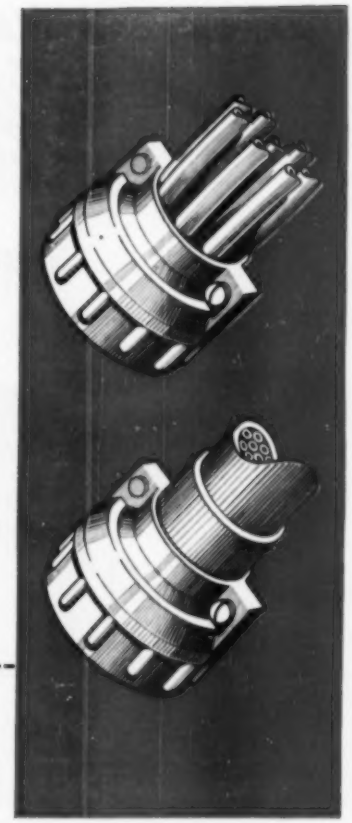

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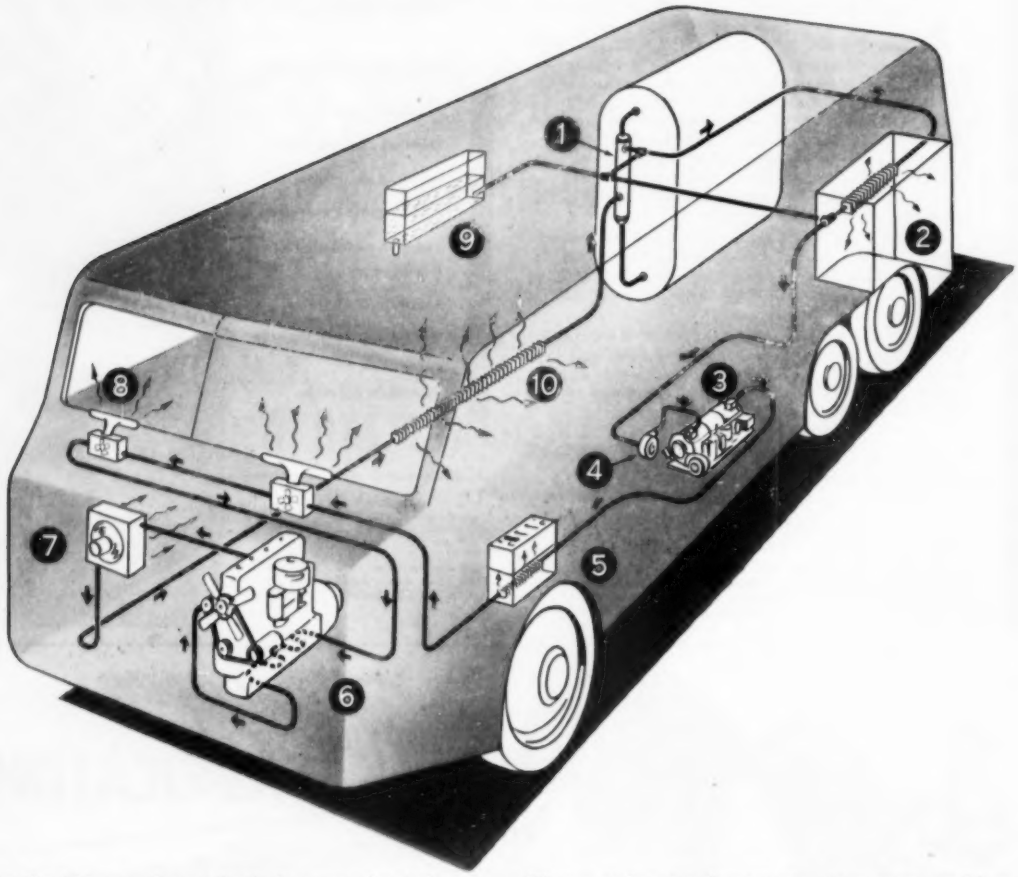

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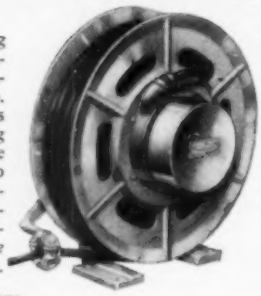

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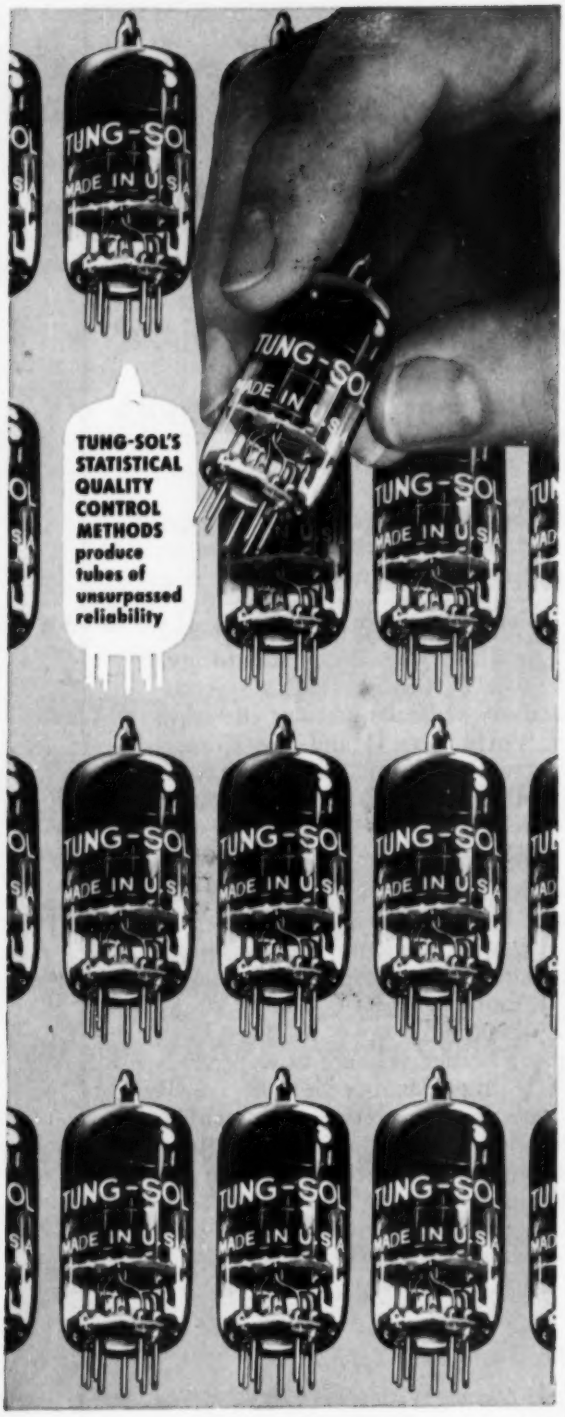

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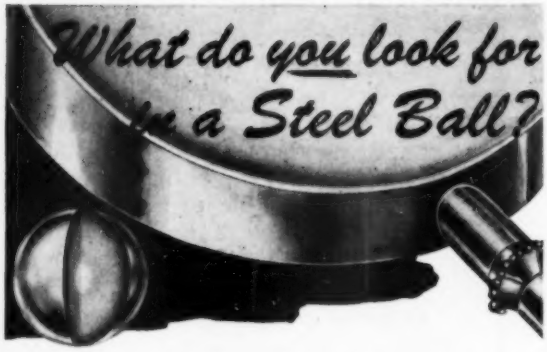

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Sgt. Ronald E. Rosser, U.S. Army

Medal of Honor

WHEN HIS BROTHER was killed in Korea, Sergeant Rosser re-enlisted. Several months later he, too, was in Korea—pinned down on a hill near Pongil-li by Red fire. He saw it cutting up the platoon. Suddenly he jumped to his feet. Alone, and armed only with a carbine and a grenade, he charged a Red bunker and cleaned it out. He dropped into a trench and dispatched five more enemies. Twice, under heavy fire, he returned for more ammunition, then renewed his attack. His one-man fight was furious—and short. It ended with 13 enemy dead, the American platoon saved, and a score settled for Sergeant Ronald Rosser.

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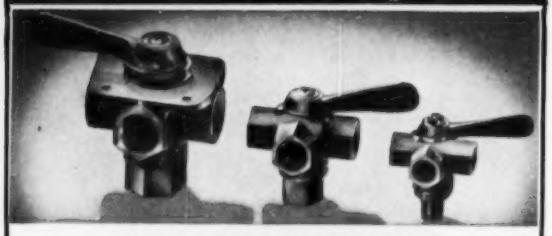

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ARMAMENT TECHNOLOGY

This section of ORDNANCE contains articles of a detailed and technical nature on ordnance research, development, manufacture, field use, and related subjects.

Off-Road Mobility

Solving the problem of fitting the vehicle to the terrain

Lieut. Col. M. G. Bekker

Operations Research Office, Johns Hopkins University, Chevy Chase, Md.

THE war of 1914-1918 was the war of railroads. The conflict of 1939-1945 was the war of highways. In the future, should a war come, the decision may depend to a considerable extent on off-the-road locomotion, the significance of which will be dramatized by airborne operations and atomic weapons. Thus, off-the-road mobility in a tactical and mechanical sense becomes the main target of technological and military achievement.

Mobility in a tactical sense may mean speed, maneuverability, agility, endurance, and practically anything which adds a tactical value to a strictly mechanical movement. Such mobility cannot be measured in a rigid quantitative way for, like an art, it expresses quality; its value may be determined perhaps best in terms of "success against purely numerical superiority." Thus mobility may be sometimes identified with economy.

However, mobility in the physical sense is a quantitative concept. It may be defined rigorously and determined in measurable units. This has been made possible through the research conducted during the past few years by the Ordnance Corps and the Operations Research Office of the Army.

According to the proposed definition, physical mobility of a vehicle depends on its performances under varying conditions of a typical terrain. It is thus a relative value and has no meaning beyond the terrain in which it is assessed. Mobility also is an operational value, because it has to be based on the importance, or frequency, or both, of the occurrence of particular operating conditions.

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It results from the foregoing that, in order to assess mobility, vehicle performance with reference to all possible terrain conditions should be determined first. To this end a physical system of values which defines soil from a locomotion point of view has been established.

SUCH a system takes into consideration two types of terrain properties which affect locomotion: (1) Physical strength of the ground, and (2) the surface obstacles of terrain; *i.e.*, the geometerical properties of the ground.

The values of the first group are measurable in accordance with soil mechanics in terms of friction, cohesion, and deformation coefficients. The second set of values is determinable in terms of length, width, and depth of the obstacle. All soil values are thus reducible to measurements in terms of pounds, feet, and seconds.

Locomotive properties of a vehicle, as such, are fully defined in terms of forces it can develop, loads it exercises upon the ground, and pertinent dimen-

sions of vehicle elements, all of which also are measurable in pounds, feet, and seconds. Thus the physicogeometrical characteristics of the ground have been determined in the same quantitative units as that of a vehicle.

The value of this system will result in the elimination of qualitative, subjective language. Now, the user is in a position to formulate his requirements in the same quantitative terms in which the engineer will interpret these requirements in vehicle design.

Such an interpretation of the user's requirements naturally follows the well-established methods of theoretical and applied mechanics and engineering sciences. It prepares the way for a new and vast field of activity which helps, for instance, to determine the required dimensions of wheels or tracks, the optimum loads of a vehicle, or its speed in a given type of terrain.

IN general, the new approach makes it possible to define any unknown value of cross-country locomotion or vehicle design by means of formulas which contain the other pertinent values of soil strength, geometry of ground surface, and the engineering data of the vehicle.

Basically, this is the same type of analysis which an aëronautical engineer or a naval architect has long since performed with reference to air and sea locomotion. Since such an approach defined vehicle performances quantitatively in particular environmental conditions, the operational evaluation of these performances in terms of mechanical mobility has been made quite possible.

Predictions of soil trafficability also may be conducted in a more rational way than heretofore, since the ground properties may be now interpreted rigorously in terms of vehicle performance.

The proposed methods enable the investigator to assess terrain not only in repect to actually existing vehicles but also in regard to vehicles which exist in the stage of ideas and specifications.

The wide field of terrain sampling to determine typical conditions of vehicle operations appears now to be open for operational analysis. Thus the possibility of soil classification from a locomotion point of view and the production of trafficability maps seem to have been established on a firm basis. From now on the meteorologist, geologist, and geographer have been provided with tangible clues to the soil-vehicle relationship.

Colonel Bekker, on leave from the Canadian Army, formerly directed research on vehicle mobility at the Canadian Department of National Defense. He is the author of the forthcoming book, "Theoretical Problems of Off-the-Road Locomotion," to be published by the Johns Hopkins University Press, Baltimore, Md.

The quantitative treatment of soil-vehicle relationships opens entirely new fields of research. For the first time a laboratory investigation of vehicle performance and its mobility appears to be in sight. For the first time a study of small scale models of land vehicles is made possible on the same basis that research on ships and airplanes has been performed in towing tanks and wind tunnels for many years.

Detailed analysis of economy and fuel consumption has been made possible without expensive full-size tests. Theoretical comparison of mobility of entirely different types of vehicles appears quite feasible on the basis of specifications and engineering design data.

An extension of the study into the history of vehicle development has shed some light upon possible future trends. Man-made locomotion on wheels seems to be somewhat inefficient when compared with the locomotion in nature; morphological studies of moving bodies provide much interesting material as to the rational form of cross-country vehicles.

Although this approach to the problem of mobility is in the stage of infancy, and much remains to be done in order to develop its full potentialities, some preliminary studies already have led to interesting conclusions.

It was discovered during World War II for instance, that radical improvement of conventional vehicle performance, and thus its mobility, is practically impossible. This unhappy outcome of numerous attempts to change the situation has been quoted often under the heading of "law of diminishing returns."

Now it can be shown readily that cross-country performance has been stabilized at fixed levels for the last quarter of a century. Such a performance index as drawbar pull per unit weight of a caterpillar vehicle has not changed for the last fifty years. The best vehicles of the world perform identically in identical conditions for all practical purposes.

The study has revealed that this is due not to the inability of the engineers to cope with the problem but to the physical laws inherent in presently developed vehicle concepts. These concepts were accepted a long time ago without any scientific study, and, after being developed on a trial-and-error basis, reached their maximum capacity.

It now appears that an entirely new field opens for an investigator, where possible future progress lies not necessarily in the technological improvement of an engine or transmission but in a change of vehicle concept.

A guide in a search for a prospective conceptual change may be sought by a better adaptation of vehicle form to the environment in which it operates.

Study has shown that present rigid vehicle forms are ill-adapted to off-the-road operation. The origin of these forms is accidental and not justified in the light of modern requirements. For instance, the stubby form of tracked vehicles is rooted in the steering concept adopted in 1905. A more rational sleek tracked vehicle cannot be produced because it will not steer even when using the most modern version of the 1905 mechanism.

THE form of wheeled cross-country vehicles in most cases is identical with the form of highway vehicles. Their only cross-country feature is perhaps a higher gear ratio or lower tire-inflation pressure and an "aggressive" tire tread. Calculations show that this can produce only limited effects.

The entirely new and unprecedented requirement for air-transportability of motor vehicles has not been met with the same revolutionary attitude toward vehicle form as that which characterizes the development of forms of aircraft for the last fifty years.

Theory and experiments indicate that

a simple change in vehicle form may improve off-the-road performance and mobility by several hundred per cent. This change appears a more promising tool of progress than purely technological improvement of vehicle elements.

In order to achieve maximum freedom in the better adaptation of the vehicle to the environment of operation, the form of the rigid bulk of certain components may have to be changed. This particularly refers to the power train whose form was developed apparently without much regard for the flexibility of vehicle design.

The substitution of a number of smaller power units for a single unwieldy large power unit may in many cases lead to greater freedom in shaping vehicle forms and to economy in their procurement.

THE application of this concept would provide the ideal solution for the standardizers and unificationists for it would produce an unlimited variety of forms of vehicles based on standard and frequently identical elements. This is the way in which Nature evolves.

Theoretical study indicates that a morphological change also is needed in other vehicle elements in order radically to improve their performance. It has been shown, for instance, that the ground-crossing ability of present tracks cannot be improved beyond the records achieved as far back as 1917; the design of spuds, grousers, and treads has only a limited effect on performance.

A radical departure from the existing forms was required in order to change this situation. New types of tracks of unorthodox design have shown unprecedented promise.

The application of the proposed methods to the study of wheel performance suggests that the form of a cross-country wheel should be different from the form of a wheel which operates on highways. The need for wheels much larger in diameter, and narrower, will be required if performance is to change radically. Such wheel forms were not accidentally developed and exclusively used by all civilizations before the advent of paved roads—the modern small-diameter "fat" tire has been developed exclusively for highway use.

What is needed, roughly speaking, is the tire form of the old Model T which had a cross-country performance as good as or better than the jeep.

An unlimited following of this trend would lead, of course, to unacceptably large diameter wheels. In order to overcome this difficulty the idea of a triangular or elliptic stationary tire, provided with a sliding rubber envelope, has been studied.

Military writers claim that campaigns and a war were lost because the "equipment was on wheels instead of on tracks." Policy makers are hesitant to procure expensive short-lived tracked equipment rather than cheaper wheeled vehicles, while designers and manufacturers claim that low-pressure pneumatic tires can replace tracks. The controversy seems to be at its peak.

From the scientific point of view there is no difference between a track, a low-pressure pneumatic tire, and a wheel. All of them can be represented as certain areas exercising certain loads upon the ground. A preliminary study of the load-carrying capacity of these areas and of their tractive forces, with reference to the ground defined in the previously described system of values, reveals that:

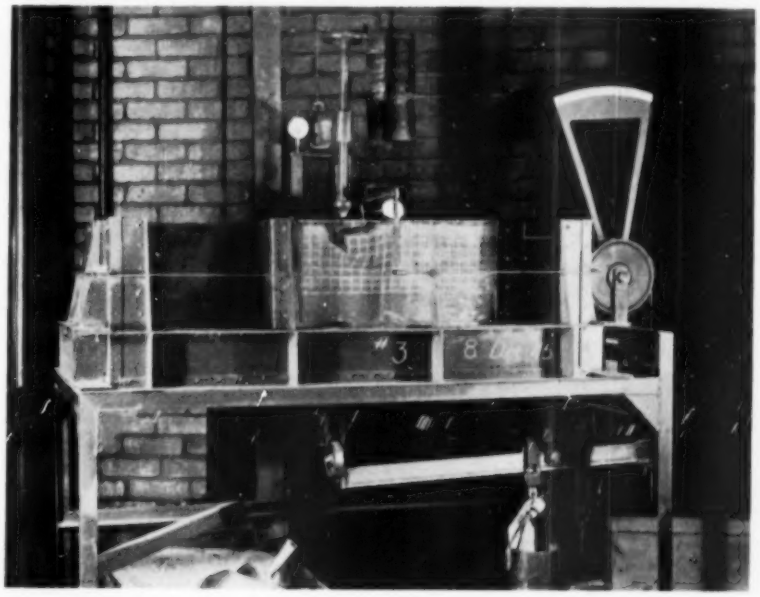
(1) A track can be replaced by an appropriate number of appropriate wheels only in so far as flotation is concerned; (2) under most soil conditions no number of wheels will ever take the place of a track because of inherent wheel slippage and lack of traction; (3) the quantitative performance differences between tracks, wheels, and tires may be determined now in terms of previously defined soil values.

THE tactical merit of these values, however, has to be determined by operational analysis. Thus a major field of study has to be covered before further rationalization of vehicle policies is achieved.

The problem cannot be solved on a part-time, nonprofessional basis. The full-time employment of professionals in aëro- and hydrodynamic laboratories suggests, by analogy, the necessity of establishing a cadre for a similar professional activity in the realm of land locomotion. The lack of such an activity appears to be in sharp contrast with the great need for mobility.

The task which lies ahead is a great challenge. Present purely technological progress will have to be paralleled by conceptual progress. This, however, cannot be done on order, or on a "project" basis. It requires the establishment of a favorable school of thought and broad interest by the universities and industry in this long-range activity. The larger the number of "pupils" the greater the chance that one of them will produce the right solution.

Apparatus for finding stress-strain distribution in soils under wheels or tracks.



The Helicopter in Combat

The impact of this versatile aircraft may bring about changes in assault concepts for our forces as far-reaching as those already occasioned by its many and varied utility functions

Joseph Bonanno

THE death rate among U. S. casualties in the Korean war was half what it was in World War II. Much of the credit for this sharp reduction must go, of course, to the development of new drugs and surgical techniques.

The bulk of the credit, however, has been given, and rightly so, to the helicopter, the use of which permitted the rapid lifesaving evacuation of the wounded from the front lines to hospital areas. If for no other reason than this, the rôle of the helicopter in military operations is assured.

The new vehicle need not, however, rest on these laurels alone, for new concepts of offensive operations are being built around the "flying windmills."

The value of the helicopter, both in civil and military duties, is derived from two flight characteristics: (1) the helicopter can rise and descend vertically, which means it can land and take off from any area that can encompass its dimensions, such as a small clearing, a road, the deck of a ship, or a mountaintop, and (2) the speed of the helicopter can be controlled, from its top speed right down to zero, without loss of lift.

IN other words it can remain motionless in the air.

In addition, it can turn on the proverbial dime, fly sideways and backwards, and get in and out of tight places with ease.

Because of these characteristics, helicopter operation is unlimited by terrain. As one helicopter pilot expressed it, "the 'copter combines the best features of the jeep, airplane, DUKW, truck, LCI, crane, and mule."

Mr. Bonanno is an aëronautical journalist whose articles have appeared in the Journal of the Franklin Institute *and in other industrial publications. His article "Flying Triangles" about the new delta-wing aircraft was published in the September-October 1953 issue of* ORDNANCE.

While this is a somewhat enthusiastic appraisal of helicopter capabilities, it is essentially correct. The helicopter can operate in mountains, in marshland, on the seas, in the desert, in the jungle, and in the Arctic—in short, in any area where men may be called upon to fight.

While other vehicles may do a better job in overcoming a particular terrain handicap, the helicopter is the only one that can do a good job *regardless of terrain*.

The value of the helicopter in assault operations was proved in Korea. On September 18, 1951, for example, the first time helicopters were used in such an operation in the fighting area, a 2,900-foot hill was taken by a helicopter assault force.

Following an assault squad which had been dropped from helicopters via a knotted rope, a fleet of 21 Sikorsky helicopters transported 224 Marines and 8 tons of weapons and supplies to the summit in 4 hours and took the hill. By traditional assault methods this feat would have taken two days. Such tactical forays as "Operation Summit" were repeated many times before the shooting war ended.

IN addition to providing the vehicle for assault, the helicopter can be called upon to fill a variety of assault-support tasks. The helicopter can supply front-line troops for an extended period with food, ammunition, and equipment, regardless of the terrain between the supply depot and the front lines. In one Korean operation a single, small Bell helicopter kept a combat force of 1,000 troops supplied for 5 days on a hilltop.

The 4,000-foot hill held by the troops was just 6 miles from their supply source, but the rugged terrain between made delivery by conventional means impossible. The helicopter shuttled back and forth, hauling 500 pounds on each trip, and carrying in a single day 3 tons of supplies and 12 additional passengers.

Other support operations include dropping patrols in isolated areas, lifting combat units over terrain obstacles, by-passing enemy forces, rapid redeployment of forces, relieving battle-weary troops, speedy reënforcement of weak positions, and a score of others.

The armed services, particularly the Marines, have been conducting extensive maneuvers using the helicopter in amphibious operations. Remembering the costly lessons of Tarawa, the Marines are eyeing the helicopter as a possible replacement for the vulnerable, slow, unwieldy landing craft of World War II.

The results of the tests conducted thus far are encouraging and underscore the unique abilities of the machine. A landing operation in which the helicopter would play the principal rôle would operate something like this:

The vessels carrying the assault force would be dispersed over a wide area rather than concentrated in the manner of World War II amphibious operations, a revision of no small importance in view of the capabilities of the A-bomb.

As for the carrying vessels themselves, virtually any ship could be adapted for such use since the required take-off area is a small one. These vessels could, furthermore, anchor well outside the range of shore batteries, say twenty-five to fifty miles out, without handicapping the operation. The Marine maneuvers showed it was possible to land an invasion force across 40 miles of water in the same time it would take landing craft to cover 8,000 yards.

Helicopters would, of course, be unaffected by tides and underwater obstacles. The question of their vulnerability to air attack is a purely academic one since no landing operation would be considered without air superiority.

Even if a landing were attempted under such adverse conditions, the helicopter would be no more vulnerable than the landing craft and would be exposed for a shorter period.

With the helicopter assault the beachhead and the many difficulties that word brings to mind would be practically eliminated, for the helicopter, unlike the landing craft, is not stopped by a shore line. The helicopter assault force could be landed inland in a more defensible position.

Once the force has been landed the helicopters could keep it supplied, shuttling back and forth from ship to shore, bringing in fieldpieces, supplies, and ammunition, and returning the wounded. Unlike one-way assaults by landing craft, gliders, and paratroopers,

(*Continued on p. 872*)

The helicopter is uniquely suited for antisubmarine operations, and the Bell XSHL-1, above, is the first of such craft specifically designed for this rôle.

In assault operations the helicopter can move troops forward or evacuate them quickly (above) or enable a commander to inspect entire forward areas (below).

The Hiller helicopter, above, hops over a marshy section of Indo-China returning wounded from the front. This was one of the first fronts to use these craft for evacuation. It is also very useful in stringing telephone wire, left. The huge Piasecki "Transporter," below, demonstrates the load-carrying possibilities of the rotor-winged craft by lifting 40 troops or 3 jeeps. It can discharge them close to the front lines without the need for prepared landing fields.

Using helicopters the Marines, above, placed a force atop a strategic hill in Korea and supplied it by the same means. In arctic operations the helicopter has many advantages over conventional aircraft as indicated in the illustration below.

the helicopter landing force could be moved quickly to another position if necessary, or even evacuated entirely if the landing proved untenable.

The helicopter appears to be ideally suited for antisubmarine and antimine work. It has several advantages over conventional aircraft in that it need not circle over the target, thereby taking the risk of losing it, and it provides a better platform for bombing.

It has advantages over the airship also in that it maneuvers more easily in rough air, it can land and take off in less space, and it requires no large hangar or ground handling crew.

The helicopter would work well in convoys. Any ship in the convoy that had thirty square feet of deck space to spare could carry its own protection in the form of an antisub helicopter.

The importance that the Navy places on the helicopter as an antisubmarine weapon was pointed up by its recent order for the first helicopter designed specifically for such work, the Bell XHSL-1.

The utility functions of the helicopter are myriad, and new uses for the machine are found virtually with every hour logged. Its most important function, apart from evacuation of the wounded, and the one which has received the greatest attention is rescue work, both on land and on the sea, where the helicopter is particularly useful in fishing out downed flyers.

Considerable attention also has been focused on the helicopter as the best vehicle for work in a disaster of A-bomb magnitude, and it will be in this type of work that the helicopter will admit no equal.

IN such a disaster, when all arteries to and from a city would probably be choked with traffic and all railroads disrupted, the helicopter would be the only vehicle capable of bringing in supplies and medical personnel quickly and flying out the injured.

Wire laying is a particular specialty of the helicopter and one which was proved in combat in Korea where, for example, one helicopter put a 20-mile line over a mountain in less than half an hour. The helicopter is not only adept at laying wire but is an excellent vehicle for patrolling the area for breaks and for making rapid repairs.

Tests conducted recently by the Signal Corps at Fort Monmouth, N. J., revealed the helicopter to be capable, not only of placing wire, but telephone poles as well. Using a Piasecki H-25 "Army Mule," the wire-laying crew was flown to the area and landed.

In addition to stringing wire, the helicopter can emplace the poles as well.

The helicopter pilot then flew back for the poles, which were of sectional aluminum construction and were carried beneath the helicopter in a sling. The poles can be carried horizontally and landed for the ground crew to set up, or they can be carried vertically and lowered into the holes.

Then the helicopter began the wire-laying operation, dropping the wire neatly over the cross bars of the po'es where it was fastened by the linemen.

The helicopter has begun to compete with the jeep as a command vehicle, permitting a commanding officer to inspect, in a short time, the entire area of his command. The helicopter is also ideal as a communications vehicle and mail carrier. It has also proved promising in aërial photography and mapping, in engineering and artillery survey work, and for meteorological operations.

Since it has proved itself as a pest-spray vehicle in civil use, it may do a similar job in germ-war decontamination work.

While the helicopter operates equally well in all types of terrain it exhibits many added advantages over conventional aircraft in the Arctic, an area of increasing strategic and tactical importance.

THE helicopter, for example, is not hampered by heavy snow on runways, it is easy to hangar since its rotors can be removed, it is not as vulnerable to high winds as conventional aircraft, ice can be removed from its rotors easier than it can be removed from wings, and, finally, in bad weather the helicopter pilot can "sit down" just about anywhere until the storm passes.

Despite the many functions the helicopter can perform as well as or better than other vehicles, the surface of its abilities has only just been scratched. As helicopter shortcomings—and there are many—are lessened, the helicopter will be found useful in many tasks now beyond its scope.

Perhaps the most important of these limitations is range. The average range of helicopters in use today is about 200 to 400 miles. As this range is increased so will the military usefulness of the helicopter.

Speed offers another challenge to helicopter engineers. Average cruising speeds of today's machines are under 100 m.p.h., admittedly high when compared with a 5-ton truck—and the comparison is a valid one—but not very high when compared with even a C-47, and the comparison is again valid.

The load-carrying ability of the helicopter also leaves much to be desired. The top load carrier in general use today can haul slightly more than two tons, or fifteen troops. The newly unveiled Piasecki YH-16 "Transporter" goes a long way toward overcoming the load handicap. This giant helicopter can carry 6 tons, or 40 troops.

There are other "bugs" to be worked out and other improvements to be made. Not the least important drawback of the helicopter is cost. They are expensive, but in view of their potential the money seems well spent.

There is no doubt that the helicopter is a military figure to reckon with. At the least it is a valuable work horse; at best it opens new concepts in assault operations.

Powder Metallurgy

A new and important industry is growing up in the United States based on the art of transforming metal powders rapidly and economically into useful objects by pressing and sintering

Kempton H. Roll

POWDER metallurgy, the art of transforming metal powders into useful objects by pressing and sintering, has developed in this country, and in Europe too, to the point where it is no longer regarded as an art but as a recognized industrial technique.

Moreover it has become highly competitive to die casting, screw machining, stamping, and other precision metal-forming methods. It has been estimated that there are five million metal powder parts now being produced each day.

What is the metal-powder industry? It consists of the producers of metal powders, the fabricators of useful objects from this material, the manufacturers of powder-metallurgy equipment, and, of course, the ultimate consumer of metal-powder parts.

ALL the metal powders are produced domestically, though iron powder is also imported. Parts fabricators are divided into two categories: "custom," or thoses that make parts to order, and "captive," or those that make parts for their own consumption.

Because of the comparative newness of this industry and the scarcity of know-how, consultants play an important rôle. Of course, in discussing any industry, one cannot ignore the customer, the final user of the product who, in this case, comprises a vast mass-production industry geared to meet the world's greatest civilian and military needs.

To obtain some idea of the magnitude of growth of the metal-powder industry, let's examine the powder-consumption picture. Copper powder is currently being used by American industry at the average rate of two million pounds a month, almost twice as much as five years ago. By far the bulk of this goes into the manufacture of self-lubricating bearings, mechanical parts, and friction materials.

Mr. Roll is assistant to the secretary of the Metal Powder Association, New York, N. Y.

Five years ago this country was consuming about a million pounds of iron powder each month. Today, iron powder is being consumed at the monthly rate of about 2,500,000 pounds with more than half of it going into the manufacture of bearings and parts.

Another way to look at the growth of iron-powder usage is to examine the capacity available to produce it. A survey made by the Metal Powder Association last spring revealed that iron-powder production capacity in the United States and Canada was over 2,200,000 pounds a month. Let me emphasize that this does not include imported powders which our consuming industry uses to a considerable extent.

The survey revealed further that additional capacity, then under actual construction, amounted to twice that figure, so that in 1954 iron-powder production capacity in this country should exceed six million pounds a month.

There are seventeen manufacturers of powder-metallurgy-grade metal powders in this country, and we are currently also using imported powders from four European countries.

From all this it becomes apparent that we are definitely not in short supply as far as powders are concerned. Now let's look at the fabricators.

It is difficult to depict the growth of the metal-power industry by showing an increase in the number of fabricators of metal-powder parts. The number of custom fabricators has not increased markedly, contrary to what might normally be expected.

THE facts are that new companies are being formed more or less regularly, but these only serve to compensate for those that are being absorbed either by metalworking concerns desiring to add powder metallurgy to their facilities or by mergers of small companies to form larger units.

There are now some seventy-five plants in the United States fabricating parts from metal powders, exclusive of those devoted to the use of flake metal powders and other special applications.

There are still other ways which show that the metal-powder industry is well out of the infant phase. Most industries, when they become big enough today, join together in trade associations to work out problems that are mutually troublesome. It was only

ten years ago that a small group of companies in this industry took that step and formed the Metal Powder Association. Today, there are fifty-two companies represented in that association.

The association develops and promulgates standards for the industry and sponsors meetings to promote the exchange of information and to help those outside the industry discover the advantages and limitations of powder metallurgy. It also computes statistical data to serve as a guide to the economics of the industry.

To aid in achieving these objectives the association has been formed into divisions, each representing a specific phase of the industry whose participants have specific problems in common. Thus far it has a Powder Producers Division, a Fabricators Division, and an Electronic Core Division.

The need for standardization and, more important, realization of this need, is strong evidence of a maturing industry, and this has certainly been the case with the metal-powder industry. Standards initiated by the Standards Committee of the Metal Powder Association, beginning in 1945, now total sixteen in number and embrace practically all phases of powder metallurgy, including electronic cores.

In addition, the American Society for Testing Materials has an active standardization program for this industry in the form of Committee B-9 which is acting in concert with M.P.A.'s Standards Committee.

The applications which gave powder metallurgy its start—those which utilized the unique characteristics of the technique—are now familiar to many. Today, those industries are well founded.

THE refractory metals such as tungsten and molybdenum at the moment are produced most economically by reduction to powder from their oxides and then formed to shape. Cemented carbides can be produced only by powder metallurgy.

The same applies to self-lubricating bearings made from bronze, iron, and stainless steel, as well as bronze, aluminum, and stainless-steel filters and other controlled permeability materials. There is no other way to make these unusual products.

The radio, television, and electronics industries consume a considerable quantity of iron powder for the production of cores and yoke coils. Sintered permanent magnets, pole pieces, rotors and stators have been in production for many years. There are ten electronic-core manufacturers in this country who last year produced more than 187,000,000 cores.

Friction materials, such as those where graphite and silica are sintered with copper, iron, tin, and lead, are used in nearly every type of power transmission unit from automobiles and farm tractors to heavy bombers and supersonic jet fighters.

BLADES for jet turbines with extremely good erosion resistance and phenomenally low creep are made from copper impregnated sintered iron. Precision rotating bands for artillery shells are being made of low-density sintered iron impregnated with paraffin wax for continuous lubrication of the gun tube.

Tungsten and silver, copper and lead —metals immiscible by melting or those with widely divergent melting points—are easily combined by powder metallurgy.

When it was first introduced, the process was used mainly on mass-produced, low-strength parts with broad dimensional tolerances. But significant advances have been made within the past few years and the field of application very substantially broadened.

Responsible are improved powders, alloy powders, better presses and die design, carbide dies and liners, and added operations such as coining or repressing and copper or brass impregnation.

Tolerances now approximate those of most established production processes. Metal-powder parts are being held to a tolerance of plus or minus 0.0005-inch by sizing or coining. In parts with the largest dimension less than two inches, a radial tolerance of plus or minus 0.001-inch and a tolerance in the direction of pressing of 0.005-inch can usually be obtained by simple pressing and sintering. It follows, of course, that the closer tolerances are secured at a price.

But with these advantages we must also recognize certain limitations. Metal-powder parts cannot be designed with undercuts, reëntrant angles, and holes vertical to the direction of pressing. These problems can be circumvented, in many instances, by designing to a semifinished blank and then finish-machining this with conventional machining operations after sintering.

An example of this practice is a brass fuze component of which more than one hundred million have been produced with a reported monetary saving of more than ten million dollars. The piece had been made, prior to 1951, on an automatic screw machine.

There are many more military fuze components in production, many more are under development, and nearly every one is an example of how powder metallurgy has frequently and profitably displaced the automatic screw machine or die casting.

Describing the dislocations of materials and tools caused by military production demands in emergencies, a consultant on powder metallurgy to Frankford Arsenal recently said that in 1951 there was only one special gear shaper in all the United States in which certain special noncircular precision gears could be made. This shaper produced one gear every 15 minutes—32 per day —and 4,000 pairs were required for the fire-control instrumentation on the Patton tank.

THREE metal-powder fabricators, he reported, said they could be tooled within thirty days and would deliver all 8,000 gears in less than one day's production on a single hydraulic press. The highest cost estimate was one dollar each, against a cost of over three dollars as produced on the shaper.

This consultant also reported that during the past fifteen months four components of the M501 mechanical time fuze have been approved for production and are, in fact, in production. Five additional components are currently under test in more or less final stages, and as soon as specifications are prepared they will be released for production.

At current production schedules and at current prices, he pointed out that there is a saving of five million dollars on parts in the M501 fuze and that there will be an additional estimated saving of at least four million dollars a year.

Availability of raw material caused many engineers, who might otherwise not have done it, to consider the use of

sintered iron because a number of the basic metals have been hard to get much of the time since the war. The availability of iron powder forced them to give it consideration and also forced them to gamble on its use since, in some cases, it was the only way production of finished goods could be continued.

The great majority of these emergency applications were quite successful and have not been changed back to their original material since the shortages have disappeared. The continued success of these emergency applications has also created confidence in engineers' minds so that they are more willing to consider and use it in more critical applications.

One of our leading business-machine manufacturers now has more than ninety different metal-powder parts in production and still more than that number in process of tooling up for production. This one company alone is now producing metal-powder parts at a rate of over thirty-six million a year —and all for use in its own business machines.

The automobile market is the largest. There are a minimum of twenty-five and as high as one hundred or more sintered parts in a passenger car. Counting replacement parts, it has been estimated that total production for automobiles will probably be four hundred to five hundred million pieces this year.

These pieces are used in many places in the automobile and are about evenly divided between bronze and steel. Bronze bearings are used in water pumps, oil pumps, distributors, starters, generators, windshield-wiper motors and connecting links, heaters, defrosters, transmissions, door hinges and latches, power-window lifts, power-seat adjusters, convertible-top linkage, radio-static eliminators, and others.

SINTERED steel is used for oil-pump gears for the engine, power steering, and automatic transmissions; pistons and valve guides for direct-acting shock absorbers; camshaft spacers and thrust washers, valve guides, clutch-spring guides, windshield-wiper parts, direction indicators, door latches, clocks, and other components.

Perhaps the increased use of metal-powder parts can be attributed in part to the fact that designers are just now beginning to recognize the advantages of powder metallurgy—some of them admittedly new-found advantages. They are beginning to consider the use of metal-powder parts in the early stages of design rather than after the design is "frozen," when the advantages of powder metallurgy cannot be used to their fullest extent.

The science of powder metallurgy actually saw its greatest early development in Europe. European powder metallurgists evolved the theories which today are the basis for our own industrial applications of powder metallurgy. But the last war upset this relationship. This country was forced to become independent of European industry because powder metallurgy became indispensable in wartime.

This method of making parts virtually eliminated losses of strategic materials in the form of scrap and either eliminated or materially reduced the need for machining operations which were not only costly and time consuming but in a machine-tool- and labor-scarce period were practically unavailable.

"Powder metallurgy as a science and powder metallurgy as an industrial process both developed more or less simultaneously, one contributing to the other—the theorists working hand in hand with the plant metallurgists. Neither one ever far outdistanced the other."

During the war this industry experienced its greatest growth. After the war we profited from our experience and not only expanded the field of applications from self-lubricating bearings and other uses unique to the art but entered into competitive fields such as the manufacture of cams, gears, and other machine parts.

This natural expansion brought with it the need for further basic research, a need which was met in this country by a growing nucleus of powder metallurgists, graduated from our own technical schools and trained in our own plants. The source of "know-how" was further supplemented by powder metallurgists coming to this country from abroad in search of opportunities.

EUROPEAN industry, after the war, was hard put to return to its original high standard with research and development as the primary goal and with production and application of secondary significance. Industry was virtually bombed out of existence in Germany, France, and England. With the signing of the armistice and the beginning of the cold war it had to be reëstablished and gotten back into production.

Basic research, then, was understandably relegated to the sidelines in Europe—not ignored but postponed. So today basic research in powder metallurgy has largely become an American responsibility both by default and by demand—the demand of a healthy, young, independent industry.

There was a time not too many years ago when any one acquainted with powder metallurgy spoke of it in terms shaded with a decided European accent. Today, this evidence of Old World charm is disappearing from the American scene, but only because today there are more American metallurgists entering the metal-powder industry.

More powder metallurgists are being graduated from American universities and colleges than ever before. Student engineers are more interested in powder metallurgy because this is a growing field offering the challenge of new horizons and, for a lot of students, it offers an interesting possibility to do thesis work in a more or less virgin field.

The metal-powder industry in the United States is young and virile and still must, on occasion, look to its European peers, but it is one which is rapidly becoming independent and self-sufficient in all respects.

As evidence in support of this is the fact that American industry this year will use more than seven times as much iron powder for powder metallurgy applications than all of Europe's industry.

Thus we have the picture of the metal-powder industry today. It is one of a robust adolescent, still growing rapidly and suffering from growing pains, but with an outlook for a long lifetime of accomplishment ahead and one which is surely taking its place in the society of industries that have long since established their places.

The Recoilless Gun

A résumé of the development of this unique arm from its early beginnings through a number of foreign experiments to its present position as an important modern weapon

Roger Marsh

UNDOUBTEDLY the invention of the recoilless gun is lost and forgotten somewhere in the misty past. It was probably an entirely unintentional development anyway, and the onlookers were undoubtedly too busy trying to extract bits and piece of the rear end of the barrel from the firer's anatomy to record that the gun hadn't—in the conventional sense, anyway—kicked.

Probably the most amusing of the early attempts to reduce recoil was the "invention" of a breech plug with a coned, recessed face instead of a flat surface presented to the powder gases. The inventor was convinced that—since the gases would thus be directed against slanting surfaces—recoil would be materially reduced.

One of the earliest recorded recoilless guns was an English piece produced in 1844. The *Illustrated London News* of October 26, 1844, pictured it (a small cannon mounted on what looked like a child's toy wagon and carrying a telescopic sight) with one of those descriptions which clearly indicated that war was on its way out again:

"THE Society of Practical Science, and Private Military School of a New and Noble Science of Warfare, having for its objects the advancement of science and the establishment of universal peace, and the placing at the command of our young and beloved Sovereign such a tremendous machinery of warfare as to enable her Majesty to maintain universal peace" produced the gun and fittings.

"The implement which excited the most attention was a cannon upon the principle of nonrecoil, which was fired several times with a strong charge of powder, without any recoil, *or certainly not more than a quarter of an inch*" (italics are mine).

The inventor of the gun also demonstrated his safety shells which were "let fall several times, when only the cap exploded," which certainly must have endeared him to the bystanders!

In Colonel Anderson's "The Mode of Manufacturing Gunpowder at Ishapore Mills" (London, 1862, Weale), edited by Lieutenant Colonel Parlby, there is an account of Parlby's experiments of a few years earlier in India. He secured an ordinary musket barrel and provided a new ignition vent at about its midpoint. The charge was then placed adjacent to the new vent, the rear half of the barrel being left empty, and the charge was fired.

Although this was not entirely recoilless, Parlby found that the projectile's penetrative power was only slightly reduced, but where the unaltered musket barrel, conventionally loaded and fired, required a 50-pound weight to keep it from recoiling, the converted barrel required only a 7-pound weight.

The first true recoilless gun was apparently that invented by G. P. Harding in England in the middle 1860's. As described by "Stonehenge"—J. H. Walsh—in "The Modern Sportsman's Gun and Rifle" (Cox, "The Field," London, 1884):

"THE effect of air resistance in a gun barrel was turned to account some twenty years ago by Mr. G. P. Harding in the production of what was called a 'nonrecoil gun.' It was certainly a curiosity in its way, but apparently not of much practical value.

"It was simply a tube, open at both ends, the charge being put in the center, with a wad behind it, and a second wad placed further toward the end of the barrel, so as to shut in air between the two in much the same manner as it would be in a gun plugged by snow.

"When the charge was fired, the shot was driven out at one end of the barrel, but the wads still remained in at the other; and a gentleman who witnessed some of the experiments informed me that he saw the gun balanced on some support, and when the charge was fired the barrel remained unmoved."

In 1911 Comdr. Cleland Davis, U.S.N., applied for patents on what was to become the "Davis Gun" of World War I. It was, in effect, a rifle

Mr. Marsh is a well-known authority and writer on foreign weapons. His article "How Good Is Soviet Ordnance?" appeared in the July-August 1953 issue of this magazine.

and shotgun hitched together along a common centerline, the rifled barrel pointing forward, the smoothbore pointing to the rear.

The charge—a solid projectile for the rifle, the interposed propellent powder, and then the mixture of lead shot or lead dust and grease for the smoothbore—was placed at the joining of the barrels. Ignition was electrical.

THE smallest Davis, a 40-mm. or "2-pounder," was ten feet long and weighed only seventy-five pounds. "It may actually be fired from the shoulder with less inconvenience than the ordinary high-power rifle," said one contemporary writer.

The intermediate "6-pounder" weighed 130 pounds, while the big "3-inch" or "12-pounder" weighed 210 pounds. (Four-inch and five-inch guns were also tried and found workable, but the two-, six-, and twelve-pounders were the only ones to see service, several hundred being used in U.S. Navy service or shipped to allied nations.)

The gun was operated by movement of a handle which rotated the rear barrel to unlock, then withdrew the barrel from the locking ring and swung it down and to the right.

The Davis gun had used a comparatively "solid" countercharge, usually of lead shot. Charles J. Cooke (U.S. Patent 1,380,358) returned to the Harding idea of using the gases themselves as the countercharge. Cooke, however, knew what he was doing, and why—and it was recoilless guns of the Cooke type which played a major rôle in World War II and in the Korean campaign.

It might be mentioned in passing that there are various vague references to experimental European recoilless guns made from conventional artillery pieces having their steel breechblocks replaced with wooden ones. These can hardly have been very successful, and certainly they did not survive as a class.

In the middle 1930's, as mobile warfare went from book to battlefield and as airborne troops became increasingly important, the new armies required lighter accompanying artillery. Obviously the recoilless gun offered a possible solution to the performance-weight problem. Both Germany and Russia turned to the design.

The Russian recoilless gun was a 76.2-mm. piece with a combined barrel and counterblast-tube length of slightly over seven feet. This weapon had a counterblast tube swinging to the right and down around a massive pivot bolt below the barrel. When closed, the counterblast tube was further locked to the barrel by mating flanges at the top. The weapon had a range of some 7,000 meters with a 10.3-pound shell.

The cartridge case was a special type with a side-mounted primer and a pressed cardboard "blowout" base. The known specimen of this gun is fitted with a shield and carried on a "naval" cone mount. Perhaps it was to have been mounted on one of those sleds so dearly loved by the Russians for winter war.

Since this gun was taken during the Russo-Finnish fighting during the winter of 1939-1940 it has a claim to fame as the first of the type used in modern warfare.

The Germans went in for recoilless guns on the grand scale. So many different companies and branches within companies were engaged in this work that apparently no one knew just who was doing what! The work was initiated in 1937.

By 1944, when their reputation as "powder-eaters" made it necessary to place drastic restrictions on their service use, at least four types of infantry recoilless guns had been placed in service. Most of these were of Rheinmetall design.

The LG-1-Rh, later designated the LG-40, was a 75-mm. gun with a range of some 6,800 yards. Weighing 325 pounds complete, it was 45 inches overall with a 29.5-inch barrel. It used the Rheinmetall horizontal sliding breechblock carrying the counterblast nozzle, but, unlike later Rheinmetall designs, it had a plastic-based cartridge with a centerfire primer. Erosion of the firing pin thus placed in the middle of the counterblast resulted in abandonment of the design.

The wide use of these guns—from Crete to Finland and from May 1941 to very nearly the end of the war—makes almost incredible the reported statement of one Rheinmetall official that only 450 were made, of which Rheinmetall made 170!

THE first of the 105-mm. recoilless guns introduced by Germany was the LG-2-Kp (perhaps a Krupp design?) with a breech system very similar to that used on the Russian recoilless gun. Later known as the LG-40 10.5-cm., it measured 6 feet 3 inches overall and weighed 850 pounds complete. Maximum range was in excess of 6,000 yards. It, unlike the 7.5-cm. LG-40, used a cartridge case with a side-mounted primer.

Another 105-mm. gun, variously known as the LG-2-Rh, the LG-40, and the LG-42, was a return to the Rheinmetall breech design. Heavier (1,200 pounds) than the LG-2-Kp, it used the same ammunition. Two versions were in use: one, the LG-40-1, used a cast light-metal mount, which was preferred, while the other, the LG-40-2, had a welded steel mount.

Biggest in the series was the 150-mm. weighing around 1,400 pounds in firing order and projecting a shell of about 90 pounds. It has been variously described as the LG-290 and the LG-292. Rheinmetall officials indicated that the LG-292 was the experimental type, service types being designated LG-42.

As the size of the guns increased, field complaints were heard about the weight of the gun and ammunition in the case of the 150-mm. The lighter guns were inveighed against largely

A 75-mm. recoilless rifle in support of infantry in Korea (Army photo).

because of the terrific report upon firing, particularly at higher altitudes, but apparently the using troops were willing to put up with that in order to take advantage of the guns' light weight, great power, and ease of handling (the LG-40's could be made ready for firing in two minutes flat, for example).

Some attempts were made to mount recoilless guns on AFV chassis. It is fortunate for us that these—particularly the project involving putting the 150-mm. on a light, full-tracked vehicle—had not progressed beyond the prototype stages by the war's end.

Rheinmetall-Borsig developed recoilless guns for other services, too. Notable were the DKM—Dusen-Kanone Marine—in two versions: the DKM-43 in 8.8-cm. for use on light patrol craft and the giant DKM-44 in 280-mm.

BOTH used the Rheinmetall horizontally sliding breechblock with counterblast nozzle, and both were nipped in development by the end of the war. The DKM-44 was still only in its early tests, but the DKM-43 was almost ready to go.

An 8.8-cm. gun firing a 20-pound projectile at almost 2,000 feet a second, the DKM-43 had a barrel over 9 feet long and weighed some 770 pounds. It was to have been fitted with an extension for the counterblast nozzle to carry the blast clear of adjacent shipboard installations, a measure presumably dictated by the results of experiments carried on initially with a standard 105-mm. recoilless gun as a guinea pig.

The DKM-44 280-mm. would have fired a 700-pound shell at a muzzle velocity of 2,450 feet a second (German sources hint at 2,600 feet a second). Unlike the DKM-43, which was to use a side-mounted mechanically fired primer, the DKM-44 was to have used electrical ignition.

Rheinmetall also produced aircraft recoilless weapons. Lieut. Col. George M. Chinn, in his monumental work "The Machine Gun," has described the Device 104 and the SG-113, both aircraft devices of the type using a massive cartridge case as a "counterprojectile." The Device 104 was a 14-inch gun firing a 1,500-pound armor-piercing projectile—the cartridge case weighing about the same amount. Total weight of the loaded unit, including barrel, was almost eight tons. Muzzle velocity of the projectile was in excess of 1,000 feet a second. It was to have been carried by a Dornier-217.

"The other type of non-recoiling aircraft cannon used by the Germans was mounted vertically in batteries and was known officially as the SG-113A . . . the counterprojectile in this arm was also the cartridge case. It was designed primarily to attack tanks from the air. The FW-190 was used to mount these 45-mm. cannon."

Two other Rheinmetall recoilless aircraft weapons were the DUKA 50 and the DUKA 88. Data and descriptions of these guns are contradictory, and little is known of them.

It is known that the DUKA 88 was not placed in service because of excessive weight and blast, which seems to have been the fate of all the larger German recoilless aircraft weapons. This gun may have been a development project paralleling the DKM-43.

There is some reason to feel that the DUKA 50 was a repeater, in which case it may have been related to the MK-115.

The Rheinmetall MK-115 was the most remarkable of all. Its counterblast channel, instead of being axially aligned with the bore, opened off the top of the bore ahead of the chamber whence it led rearward above an automatic feed only to dip down so that its final rearward turn put it almost in line with the bore, its venturi nozzle aimed directly to the rear.

A gas-operated locking and ramming mechanism completed this weird device. It is reported that the Germans were experimenting with nitrated paper cases for it, but the thought of trying to run paper artillery ammunition through an automatic ramming mechanism is enough to give any ordnanceman cold chills. It was a 55-mm. weapon.

The Japanese apparently missed the boat on recoilless weapons. Found at a Japanese army proving ground after the war were the forlorn relics of their ventures into the field, two 81-mm. and one 105-mm. recoilless guns, apparently the only things of their kind in the whole archipelago.

The two 81-mm. guns were slightly different—one was 73 inches overall with a 7.5-inch-diameter counterblast nozzle, the other was 67 inches overall with an 8.25-inch-diameter nozzle. Both were smoothbored and both were muzzle-loaders, apparently made from converted mortars and very possibly designed to use modified mortar ammunition, since they had center-fire firing mechanisms.

The development of recoilless guns in the United States has been adequately covered in such works as Maj. Gen. G. M. Barnes' "Weapons of World War II" and in past issues of ORDNANCE, particularly in the Studler and Hedge articles in the September-October 1945 issue (Vol. XXIX, No. 152).

Since World War II development of recoilless guns has been considerable—and by no means confined to the United States. The French, for example, unveiled their new recoilless 75-mm. in March 1951. It closely resembles the U.S. 75-mm. but uses a special light high tripod.

ALSO early in 1951 the Chinese Communist forces introduced their 57-mm. recoilless rifles. (An apocryphal story recounted by J. P. Conlon, recently of the Land of the Morning Calm, has it that in demonstrating the new weapons the CCF in one case clobbered several squads with the back blast and then, convinced that it had mistaken the business end of the gun, reversed it for one more try—and one more squad!)

The CCF 57-mm. looks enough like the U.S. 57-mm. to be its rather battered twin brother. Reportedly, the CCF proposes to use it as an antitank weapon.

At the time of writing, the most recent recoilless gun is the British BAT (battalion antitank) 120-mm. recoilless rifle. Weighing 2,200 pounds in firing order, it is mounted on a low-slung, 2-wheel carriage designed for high-speed towing. The towing gear is attached to the gun's muzzle. The breech mechanism included a vertical falling block carrying the counterblast nozzle and having a loading tray mounted atop the block and nozzle.

This is an interesting weapon, but it must be recorded that a weight of 2,200 pounds for a 120-mm. gun will almost certainly be compared unfavorably with the 1,400 pounds of the German 150-mm. gun.

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MARCH-APRIL 1954

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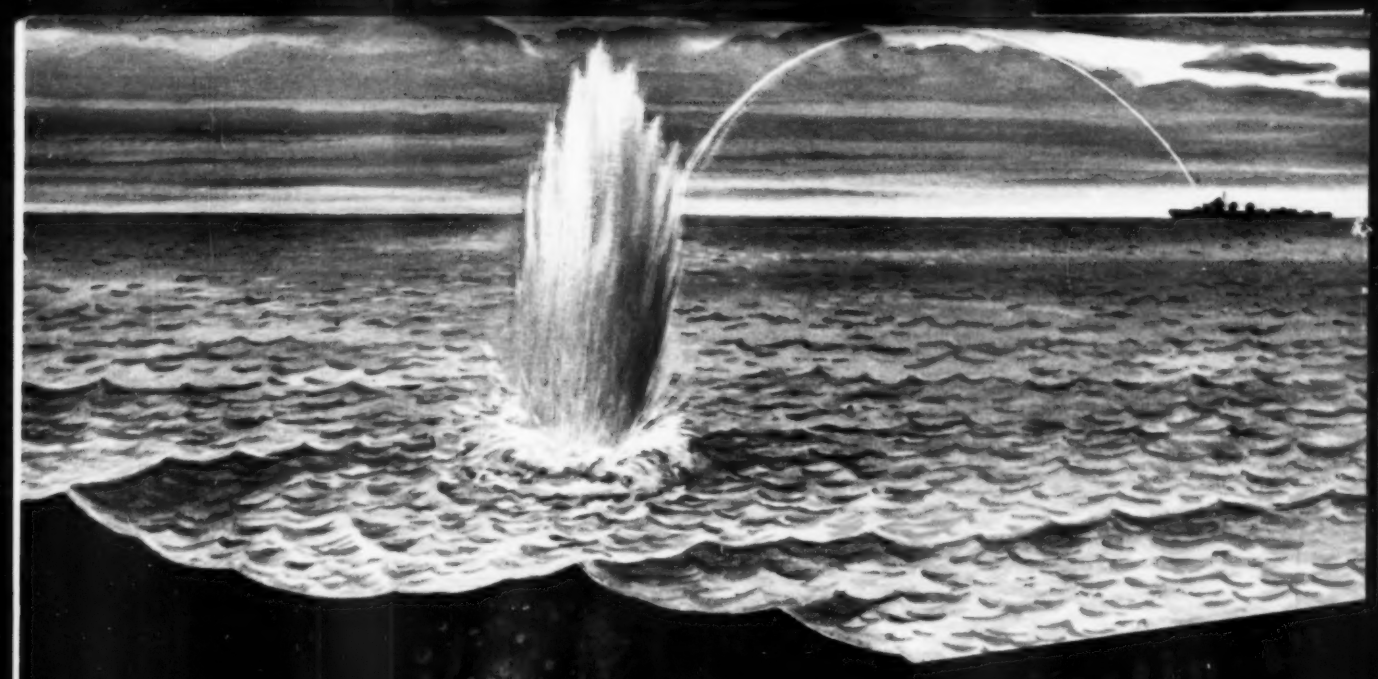

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